DOCUMENT RESUME

ED 312 802 EC 221 260

AUTHOR	Alamprese, Judith A.; Erlanger, Wendy J.
TITLE	No Gift Wasted: Effective Strategies for Educating Highly Able, Disadvantaged Students in Mathematics and Science. Volume I: Findings. Final Report.
INSTITUTION	COSMOS Corp., Washington, DC.
SPONS AGENCY	Department of Education, Washington, DC. Office of Planning, Budget, and Evaluation.
REPORT NO	ISBN-0-942570-34-0
PUB DATE	Mar 89
CONTRACT	300-87-0152
NOTE	102p.; Paper presented at the Annual Convertion of the Council for Exceptional Children (67th, San Francisco, CA, April 3-7, 1989). For volume 2, see EC 221 261.
PUB TYPE	Reports - Descriptive (141) -- Reports - Research/Technical (143)
EDRS PRICE	MF01/PC05 Plus Postage.
DESCRIPTORS	Ability Identification; Acceleration (Education); Economically Disadvantaged; *Educational Practices; Elementary Secondary Education; *Enrichment Activities; *Gifted Disadvantaged; *Mathematics Education; Program Administration; *Program Development; Program Implementation; Pupil Personnel Services; School Administration; *Science Education

ABSTRACT

General findings from an analysis of district-wide and school-level efforts to develop highly able, economically disadvantaged students' academic skills and creative talents in mathematics and science are described. Data were collected from 29 school districts or schools located throughout the United States. Telephone interviews were conducted with representatives from each site; case studies were conducted at nine sites. The analysis revealed a number of effective approaches for serving these students. Many of the programs identified students through a pre-selection process and the use of multiple criteria. The programs provided both enrichment activities and accelerated courses involving extension of time students spend learning, operation of special programs, use of hands-on learning techniques, and provision of out-of-school activities. Support activities included setting external goals, providing career awareness programs, providing social-emotional support, and encouraging parent participation. Processes used to manage and maintain programs included using a district-school co-management approach; involving community organizations, businesses, industries, and universities; and recruiting parents and school alumni to support the program. School districts permitted flexibility in program implementation, provided staff support, and recruited qualified staff. The report's appendices describe the study approach and methodology and summarize programs that were not selected as case study sites. (JDD)

NO GIFT WASTED:

Effective Strategies for Educating Highly Able, Disadvantaged Students in Mathematics and Science

Volume I: Findings

Prepared Under Contract by:

COSMOS Corporation
Washington, D.C.

Contract No.: 300-87-0152

U.S. DEPARTMENT OF EDUCATION • OFFICE OF PLANNING, BUDGET & EVALUATION

NO GIFT WASTED: EFFECTIVE STRATEGIES FOR EDUCATING HIGHLY ABLE, DISADVANTAGED STUDENTS IN MATHEMATICS AND SCIENCE (VOLUME I: Findings)

Judith A. Alamprese
Wendy J. Erlanger

March 1989

Final Report Prepared for the U.S. Department of Education, Office of Planning, Budget and Evaluation under Contract No. 300-87-0152

COSMOS Corporation

ISBN No. 0-942570-34-0

COSMOS Production Assistant: Bernice Hughes

The conduct of this study and the preparation of the final report were sponsored by the U.S. Department of Education, Office of Planning, Budget and Evaluation under Contract No. 300-87-0152. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the authors and do not reflect the views of the U.S. Department of Education.

PREFACE

This document is Volume I of the final report of a study that was conducted by COSMOS Corporation during 1987-1988 for the U.S. Department of Education's Office of Planning, Budget and Evaluation. This volume describes the general findings from an analysis of district-wide and school-level efforts to develop economically disadvantaged students' academic skills and creative talents. Volume II presents nine case studies of effective district and school-level programs for serving highly able, disadvantaged students in mathematics and science.*

The impetus for the study was the U.S. Department of Education's desire to understand the efforts being made by school districts to educate their most able, disadvantaged students and to prepare them for postsecondary education. The Department also was interested in learning about ways in which funds awarded under Title II of the 1984 Education for Economic Security Act (P.L. 98-377) have been used to foster the academic development of students in mathematics, science, and the critical foreign languages.

During the course of the study, data were collected from 29 school districts or schools located throughout the country. Telephone interviews were conducted with representatives from each of these sites, which offered a variety of instructional programs for highly able students. Case studies were conducted at nine sites. Thus, the study is based upon a wealth of information about diverse efforts that are being undertaken to provide disadvantaged students with enhanced educational opportunities.

Our data collection activities would not have been possible without the cooperation of the representatives from each of the sites examined in the study. Their willingness to describe their efforts and share with us their successes and frustrations in providing quality programs is deeply appreciated. Our gratitude also is expressed to those who organized our case study site visits, and to the faculty, staff, students, parents, community and school board members who graciously met with us and provided us with detailed information about program operations.

At critical points throughout the study we benefited from the guidance of the staff of the U.S. Department of Education, Office of

---

*Alamprese, J.A., W.J. Erlanger, and N. Brigham. 1988. _No gift wasted: Effective strategies for educating highly able, disadvantaged students in mathematics and science, volume II: Case studies._ Washington: COSMOS Corporation.

Planning, Budget and Evaluation. Arthur Kirschenbaum, our project monitor for the study, provided advice on each of the study's phases. We wish to acknowledge his support throughout our effort. Other members of the U.S. Department of Education who provided thoughtful insights are: Alan Ginsburg, Valena Plisko, Nina Winkler, Carol Chelemer, Alan Schmieder, Charles Lovett, and Joanne Wiggins.

Special thanks are extended to the study's three advisers: William G. Durden, The Johns Hopkins University; Paula M. Olszewski-Kubilius, Northwestern University; and Patricia Bruce Mitchell, National Association of State Boards of Education. Their assistance in identifying effective district and school programs and in reviewing all study documents has been invaluable. Finally, we wish to thank the numerous researchers and practitioners who provided us with nominations of promising approaches for serving highly able, disadvantaged students.

The members of the COSMOS team who conducted this study are: Judith A. Alamprese, the principal investigator; Wendy J. Erlanger and Nancy Brigham, who joined Judith Alamprese in the study's design and data collection activities; Joanne Capper, who served as a case study site visitor; and Robert K. Yin, who provided guidance as the study's corporate reviewer.

Finally, while we are thankful for the assistance provided by others, the authors alone are responsible for the contents of this final report.

Judith A. Alamprese
Wendy J. Erlanger

COSMOS Corporation

EXECUTIVE SUMMARY

CASE STUDY SITES

- Baltimore Polytechnic Institute
  Baltimore, Maryland

- Challenge '85
  Salina, Oklahoma

- Gifted and Talented Program
  James A. Garfield High School
  Los Angeles, California

- Richmond Community High School
  Richmond, Virginia

- Detroit Area Pre-College Engineering Program
  Detroit, Michigan

- Gifted and Talented Program
  Chicago Public Schools
  Chicago, Illinois

- Encendiendo Una Llama
  Hartford, Connecticut

- Potentially Gifted Minority Student Project
  West Palm Beach, Florida

- Training of Elementary School Teachers in Mathematical Thinking
  Fort Worth, Texas

EXECUTIVE SUMMARY

Background

The Secretary of Education has called for strategies to bring disadvantaged students into the educational mainstream. The loss of disadvantaged children to school failure is a moral and economic waste that the United States cannot afford. Moreover, when disadvantaged children show promise in school, their loss to low expectations, boredom, and lack of support is doubly disturbing. Yet this happens all too often:

- Minority students are underrepresented in programs designed to serve gifted and talented students. Although minorities make up 30 percent of public school enrollment, they represent less than 20 percent of the students selected for gifted and talented programs;

- Whereas students from low-income backgrounds comprise 20 percent of the student population, they make up only 4 percent of those students who perform at the highest levels on standardized tests (those who score at the 95th percentile or above);

- High school seniors from disadvantaged families (in which the mother did not complete high school) are less than half as likely to have participated in gifted and talented programs as more advantaged seniors; and

- Disadvantaged students are far less likely to be enrolled in academic programs that can prepare them for college and are about half as likely to take coursework in advanced math and science than more advantaged students. Only 2 percent of high school seniors from poor families take calculus, whereas approximately 7 percent of those from more advantaged backgrounds do.

Indeed, the U.S.'s poor showing on international assessments in mathematics and science suggests that U.S. schools are not developing our students to their fullest, particularly those from disadvantaged backgrounds.

In light of these concerns, the Office of Planning, Budget and Evaluation in the U.S. Department of Education funded COSMOS Corporation to identify successful efforts by districts and schools to serve highly able, economically disadvantaged students, and to foster their achievement in mathematics and science.

Overview of the Study

This study documents the operation of nine exemplary programs, and the lessons learned from the implementation of these programs for educating disadvantaged students. From a national search, nine sites were selected on the basis that they served a high percentage of disadvantaged students, used multiple measures to identify promising students, employed successful curricular or administrative programs, and showed evidence of effectiveness.

In addition to meeting these criteria, the exemplary programs showed the potential for being transferred to another educational setting, or had a component that could be adopted by others.

In order to gather information about the ways in which school districts and schools are serving highly able, disadvantaged students, individual case studies of the nine programs were conducted. A cross-case analysis of the nine sites was undertaken to identify the key issues that should be considered in serving highly able, disadvantaged students in science and mathematics.

Findings

The analysis of school programs revealed a number of effective approaches for serving highly able, disadvantaged students that were common to most sites. Although the operations differed from site to site, the projects shared similar strategies for identifying, selecting, instructing, and supporting these students. In addition, good

management practices characterized these programs. The role of the school district in supporting the implementation of school programs also was significant. Conclusions about each of these efforts are described below.

Identification and Selection of Students

A primary objective of the programs examined in the study is to identify and serve minority and economically disadvantaged students, who traditionally have not had opportunities to develop their gifts and talents fully. One of the problems for these students is they may not perform as well as more advantaged students on traditional tests used for selection into gifted and talented programs. Because many of these students have not had the background and test-taking practice to do well on these tests, they are often excluded from consideration. Processes that are being used to identify and select students to uncover their potential are:

- A pre-selection process, such as the activity-based assessment used in the Potentially Gifted Minority Student Project to identify promising students. By such a process, students are encouraged to develop and display their skills and abilities over an extended period of time, in order to increase their prospects for admission into a gifted and talented program; and

- The use of multiple criteria for selecting students for admission into a gifted and talented program, rather than a single measure such as a standardized test. Criteria include achievement and aptitude test results, teacher recommendations, and students' classroom performance.

These strategies are particularly successful in programs such as Encendiendo Una Llama where children may be limited in English proficiency.

Instruction of Students

Disadvantaged students may need extra instruction to develop their abilities. The programs identified in our study provide both enrichment activities and accelerated courses. These efforts are designed to bolster students' current knowledge of subject content, extend their capacities for learning, and enhance their life experiences. Enrichment and acceleration strategies that are being implemented include:

- The extension of time students spend learning, through the provision of after-school, weekend, and summer enrichment and accelerated courses;

- The operation of special programs in the elementary grades to prepare students early for acceptance into highly selective gifted and talented programs;

- The provision of accelerated courses for students at local universities and in programs offered by specialized schools in science and mathematics;

- The use of hands-on learning techniques, such as laboratory classes and independent research projects, to teach students how to apply mathematical and scientific concepts; and

- The provision of out-of-school activities designed to enhance students' cultural and intellectual development, including museum programs, mentorship programs with business and industry, and field trips.

James A. Garfield High School's Gifted and Talented Education program has made masterful use of instructional time through summer and weekend classes. Teacher Jaime Escalante is well known for an instructional approach that engages students through application of mathematical principles to real life experience.

Support of Students

Many students are not aware of what they can accomplish and too often become frustrated and discouraged. Districts and schools engage in a variety of activities to support disadvantaged students as they take on a more demanding program. These activities are aimed at motivating students to achieve beyond their expectations, including the pursuit of postsecondary education. These efforts include:

- Setting external goals that students can work toward, such as winning an academic contest or passing the Advanced Placement examination;
- Provision of career awareness programs to inform students about the professional opportunities available in the fields of mathematics and science;
- Provision of social-emotional support to students, through teachers' and counselors' active involvement in students' lives; and
- Encouragement of parent participation in students' academic development and in supporting their emotional growth.

The Richmond Community High School program places particular stress on comprehensive support services, including providing each student with a "family," a teacher-led student discussion group that meets daily.

The Administration and Management of Programs

In our study, districts and schools work together and with their communities to provide a variety of opportunities for disadvantaged students, who have limited access to community resources. The success of these efforts in offering continuous reinforcement to students has been due, in part, to the management strategies adopted by districts and schools in carrying out and supporting their work. Processes used to manage and maintain programs are the following:

- Use of a district-school co-management approach whereby districts allow flexibility in the implementation of policy, so that schools can tailor programs to meet the individual needs of their students;

- Provision of opportunities for students to continue their participation in a gifted program throughout their educational career so that programs at the elementary school level feed into ones at the high school level;

- Involvement of community organizations, businesses, industries, and universities in supporting the operation and expansion of school programs; and

- Recruitment of parents and school alumni to assist in fundraising efforts and to support academic activities.

For example, the governance of Detroit Area Pre-College Engineering Program is shared by the Detroit Board of Education, local universities, corporations, foundations, and parents.

School District Support of School Programs

The school district plays an important role in supporting school efforts to serve highly able, disadvantaged students. In particular, districts do the following to ensure the success of school programs:

- Permit flexibility in the implementation of programs. In order to provide laboratory classes and specialized curricula in mathematics and science, schools need flexibility in scheduling and expending funds for materials and equipment;

- Provide staff support for the operation of special programs. The successful operation of a program may require staff support from the district, in order to facilitate the participation of multiple schools in a program or to coordinate the services provided by the district to a special program;

- Recruit qualified staff for mathematics and science programs. In order to ensure that schools have staff qualified to teach advanced mathematics, science, and engineering courses, school districts may have to provide incentives for professionals from business and industry to teach, recruit new qualified teachers, and provide inservice training to upgrade the skills of existing teachers; and

- Promote partnerships with business, industrial, and community organizations. In order to provide enrichment activities for disadvantaged students, school districts may need to work with local businesses and community organizations to encourage their participation in special programs and their contribution of resources to support activities.

The Baltimore City Public Schools have allowed the Baltimore Polytechnic Institute Program to modify class schedules to offer double periods in which laboratory experience can be integrated with theoretical instruction.

Conclusion

These programs have worked because they hold high expectations for their students, provide an enriching curriculum, and offer support as students progress through school. They succeed due to the combined efforts of school districts, schools and community organizations to nurture talent and encourage higher performance in low-income urban and rural areas. They create a supportive environment for learning in often inhospitable surroundings.

At the district level, this means a willingness to forego regimentation and a commitment to seek out resources to support programs. At the school level, support is manifest in principals and teachers who care about their students' academic and personal development and are willing to spend the extra time and effort needed to stimulate a love of learning.

Community organizations also contribute; they can widen students' horizons and opportunities through internships and extracurricular pursuits.

The nine sites identified through this study, while obviously not the only programs that are successful in educating highly able disadvantaged students, are offered as examples for other districts and schools to follow.

CONTENTS

VIGNETTES

Appendix

FIGURE

TABLES

I. INTRODUCTION

Educational Reform: Context for a Study

During the past decade, the nation's attention has been focused on the need to improve the quality of American education. The decline in student achievement and concerns with teacher performance, particularly in science and mathematics, have been well documented and extensively discussed (e.g., National Commission on Excellence in Education, 1983; National Science Foundation, 1983; Twentieth Century Fund Task Force, 1983; Carnegie Forum on Education and the Economy, 1986; Council of Chief State School Officers Study Commission, 1986; and the Holmes Group, 1986). What has emerged from these analyses is a consensus concerning the problems with our educational system that need to be addressed if our society is to regain ground and increase its capacity to compete globally in the 21st century. Prominent among these problems is the necessity to enhance our capacities to meet the unique needs of economically disadvantaged and minority students. Also pressing is the need to expand opportunities for these students to develop their talents in science and mathematics.

Children in Poverty. As the proportion of children living in poverty and experiencing family disruption continues to increase, the education of these children poses special challenges for school systems across the country. For example, in 1985, about 20 percent of all children and 54 percent of children in female-headed families were classified as economically disadvantaged (U.S. Department of Education, 1988). Children existing in environments of poverty suffer from hunger, lack of medical care, and inadequate housing. They also have fewer educational materials that they can use at home, and are less likely to have parents with formal education who assist with homework and who participate in school activities. In addition, economically disadvantaged children have limited opportunities to interact with employed individuals who can serve as role models.

As a result of these conditions, the development of childrens' cognitive, linguistic, and other educational and job-related skills

necessary for the world of work is adversely affected. In particular, disadvantaged and minority children with academic potential often are not identified as having talent, and are not given opportunities to develop their abilities in specialized programs. During 1986, only 19 percent of the students enrolled in our nation's gifted and talented programs were minorities, although minorities comprise 30 percent of the total student enrollment in public schools (U.S. Department of Education, 1986). Furthermore, students from disadvantaged backgrounds frequently lack the support structures that are critical for fostering their academic and social success (Schorr, 1988 and Wilson, 1987).

The Mathematics and Science Dilemma. Designers of educational reform efforts are concerned not only about the special needs of disadvantaged children, but also about the number of students who are not prepared to work in our technological society because of inadequate training in mathematics and science. The increasing demands on the workforce in the year 2000 will require employees to have higher mathematics, language, and reasoning capabilities than the current population. For example, while 27 percent of existing jobs require advanced skills in these three areas, by the year 2000 the percentage of jobs with these skill demands is expected to increase to 41 percent. Thus, jobs that traditionally have required workers to possess reading and mathematical skills will, in the future, require proficiency in reasoning, information processing, and other higher order skills (Johnston and Packer, 1987).

Recent studies suggest that much progress needs to be made in developing these skills. The Second International Mathematics Study found that the United States' standing is very low relative to other countries, both in terms of high school students enrolled in advanced mathematics courses and the amount of mathematics that students know (McKnight et al., 1987). The 1986 National Assessment of Educational Progress (NAEP) results indicate that although the performance of black and Hispanic students in mathematics has increased relative to past assessments, the net gains have been confined to lower-order skills. Improvements are needed not only in average proficiency, but also in

the number of students who reach upper levels of performance (Dossey et al., 1988).

The picture in science is similar. The NAEP findings show that the majority of high school students are not well equipped to be informed citizens and productive members of the workforce. Only 7 percent of the students tested in 1986 have the knowledge and skills necessary to perform work in college-level science courses. Furthermore, the study found that half of the 13-year-olds tested lacked an understanding of the basic elements of scie[illegible], and nearly 30 percent of the nine-year-olds had not developed an understanding of scientific principles (Mullis and Jenkins, 1988).

In addition to the need for increased participation in advanced mathematics and science and improved achievement in math and science courses (e.g., National Research Council, 1985 and Murnane and Raizen, 1988), recent research suggests that more efforts are needed to foster students' positive attitudes toward mathematics and science, including career awareness activities (e.g., Berryman, 1983; Malcom, 1984; Boswell, 1985; Eccles et al., 1985; and Clewell, 1987). Studies indicate that negative attitudes toward mathematics and science, as well as a lack of information regarding careers in these fields, represent barriers to participation, especially for disadvantaged and minority students.

Responses to the Call for Reform. The publication of studies and reports about the general condition of education, the acknowledgment of the needs of disadvantaged students, and the problems in achievement in academic subjects such as science and mathematics, have stimulated much discussion and action across all levels of governance. The issues are being addressed through national efforts--such as the Holmes Group's (1986) work to restructure teacher education; by statewide initiatives in educational reform--such as those in California, Illinois, and North Carolina; and by school district programs to address the local needs of students and teachers. In particular, the concern about mathematics and science has encouraged the design of research projects and model curricula, prompted the development of new curriculum standards in

mathematics (NCTM, 1987), and stimulated the interest of private foundations to explore ways to assist with national improvement efforts in technology (Yin et al., 1988). Furthermore, the enactment of the 1984 Education for Economic Security Act (P.L. 98-377) has provided additional resources for state education agencies and institutions of higher education to foster the development of gifted students in the fields of mathematics, science, foreign language, and computer learning. Additional resources also have been made available as a result of increased National Science Foundation funding for projects in pre-college science and mathematics.

A Study of Effective District and School Programs

In light of the concerns about the quality of American education, the U.S. Department of Education's Office of Planning, Budget and Evaluation (OPBE) funded COSMOS Corporation in 1987 to investigate the efforts that are being made by school districts and schools to serve highly able, disadvantaged students. The Office of Planning, Budget and Evaluation was interested in identifying both district-wide strategies and individual school practices that have been effective in reaching disadvantaged students and in improving their achievement in mathematics, science, and the critical foreign languages--Japanese, Chinese, and Russian.

In the study, the case study method was used to document the operation of nine model programs, and the lessons learned from the implementation of these efforts for educating highly able, disadvantaged students. While an attempt was made to select nine programs for fostering students' achievement in mathematics, science, or the critical foreign languages, no critical language programs that met the study's criteria were identified. This volume presents the findings from a cross-site analysis of the nine programs examined in detail, and identifies critical issues that should be considered in nurturing the development of highly able, disadvantaged students. A companion volume presents case studies of the nine programs, which describe the

efforts being made to develop students' abilities in mathematics and science (see Alamprese, Erlanger, and Brigham, 1988).

Summary of the Study's Methodology

Identification of Sites. A multi-stage process was used to identify nine exemplary district and school programs for serving highly able, disadvantaged students in mathematics, science, and the critical foreign languages. First, criteria were specified for defining the study's four major selection factors: 1) percentage of economically disadvantaged students; 2) use of multiple measures in identifying highly able, disadvantaged students; 3) type of program--either a curricular practice or administrative arrangement; and 4) evidence of effectiveness. Specifically, each program selected as a case study site had to meet the following conditions:

1. Percentage of economically disadvantaged students: a program had to be in a school district in which at least 30 percent of its students is eligible for the federal school lunch program, and in which at least 20 percent of the students served by the strategy is eligible for the school lunch program;

2. Use of multiple measures: a program had to identify highly able, disadvantaged students using at least one standardized measure of student achievement or intelligence, and at least one other indicator of student ability, such as assessment of classroom performance or a teacher's recommendation;

3. Type of program: a program had to be either a curricular practice--accelerated curricula, enrichment activities, or administrative arrangements--early identification procedures. inservice education programs; and

4. Evidence of effectiveness: a program had to present evidence of being effective in at least one of the following: a) increasing student achievement in mathematics, science, or the critical foreign languages; b) increasing student enrollments in one of these fields; or c) en-

couraging students to pursue higher education and/or careers in one of these fields.

In addition to meeting the study's four criteria, a program selected as a case study site had to have the potential for being transferred to another education setting, or have a component that could be adopted by others. It also was intended that the sites be geographically diverse, include rural, urban, and suburban settings, serve students at a variety of grade levels, and represent various types of curricula and administrative arrangements.

A national search for nine exemplary sites was undertaken, and 79 nominations were identified. These sites were screened, and 29 candidate sites that appeared to meet the study's criteria were selected. These sites were reviewed further, and nine were approved by OPBE. An overview of the nine sites selected for case studies is presented in Table 1.

Each of the nine programs met the study's criteria for serving highly able, economically disadvantaged students and had evidence of attaining at least one outcome. In fact, the majority of the case study sites served a greater percentage of economically disadvantaged students than was required for participation in the study. The programs also represented a variety of approaches, including identification and enrichment programs for elementary students, a district program with several components, and a teacher-training program. In addition, the case study sites were varied in terms of their implementation approach, as is displayed in Table 2. Two of the nine sites are district-wide efforts with multiple components, which are being used by schools throughout the districts. Four are a district-sponsored single practice that is being used by multiple schools in a district, and three are school-level programs. The selection of these approaches permitted an examination of the differing ways in which school districts support the delivery of educational services to their students.

Case Study Site Visits. In order to gather information about the ways in which school districts and schools are serving highly able,

Table 1

OVERVIEW OF NINE CASE STUDY SITES

Site	Substantive Focus	Practice Type	Target Pop.	Geog. Location	Area Served	%Econ. Disad. Prog./ Dist.	No. of Select. Crit. Met	Effect. Data
Baltimore Polytechnic Institute Baltimore, MD	M,S, Engin.	Magnet School (Curric.)	Students: Grades 9-12	NE	Urban	33%/51%	3	Post Program Participat.
Challenge '85 Salina, OK	M,S	Curric.	Students: Grades 11-12	MW	Rural	45%/50%	2	Post Program Participat.
Gifted & Talented Program James A. Garfield High School Los Angeles, CA	M,S	Curric.; Counseling Component; Under-Achiev. Gifted Track	Students: Grades 10-12	W	Urban	98%/46%	2	Student Achiev.
Richmond Community High School Richmond, VA	M,S	Alternat. School (Curric.)	Students: Grades 9-12	SE	Urban	70%/49%	4	Post Program Participat.
Detroit Area Pre-College Engineering Program (DAPCEP) Detroit, MI	M,S, Engin.	Mid. Sch. Curr.; Sec. Sch. Enrich and Summer Program	Students: Grades 7-12	MW	Urban	45%/41%	4	Post Program Participat.
Gifted & Talented Program Chicago Public Schools Chicago, IL	M,S	Curric.; Museum Collabor.; ID/Tracking	Students: Grades K-12	MW	Urban	52%/68%	4	Student Achiev.
Encendiendo Una Llama Hartford, CT	M,S	Curric.; Mentorships; Enrichment;	Students: Grades K-12	NE	Urban	80%/45%	3	Post Program Participat.
Potentially Gifted Minority Student Project W. Palm Beach, FL	M	Curric. w/Enrich.	Students: Grade 4	SE	Suburban/ Rural	80%/30%	2	Student Achiev. Post Program Participat.
Training of Elem. School Teachers in Mathematical Thinking Fort Worth, TX	M	Inservice Training	Math. Teachers: Grades K-6	SW	Urban/ Suburban	N.A./60%	2	Changes in Teachers' Attitudes & Abilities

Table 2

TYPE OF STRATEGY

Site	District-Wide Effort with Multiple Program Components	District Program Implemented in More than One School	School-Level Program, Implemented in One School
Baltimore Polytechnic Institute			X
Challenge '85		X	
Gifted & Talented Program, James A. Garfield High School			X
Richmond Community High School			X
Detroit Area Pre-College Engineering Program	X		
Gifted & Talented Program, Chicago Public Schools	X		
Encendiendo Una Llama		X	
Potentially Gifted Minority Student Project		X	
Training of Elem. School Teachers in Mathematical Thinking		X	

economically disadvantaged students, case study site visits of the nine programs were conducted. During the site visit, each of the programs was examined in terms of the following functions: 1) development of the program, 2) program operation, 3) student identification and selection process, 4) program staffing, 5) support services, 6) funding and administration, 7) program impact, and 8) transferability. The information collected during the site visits was analyzed, and separate case studies were prepared for each site. Finally, a cross-case analysis of the nine sites was undertaken to identify the key issues that should be considered in serving highly able, disadvantaged students in science and mathematics. Presented in Appendix A is a detailed description of the study's approach and methodology.

Overview of This Volume

This report describes our findings regarding the development of the skills and talents of economically disadvantaged students in mathematics and science. The remaining sections included in this volume are:

- Section II--strategies for identifying and selecting highly able, disadvantaged students;
- Section III--curricula and teaching methods that are used in the education of highly able students, with an emphasis on the enhancement of students' mathematical and scientific skills;
- Section IV--support structures for fostering the academic and social-emotional growth of economically disadvantaged students;
- Section V--administrative and management resources used by school districts and others to support the operation of exemplary programs;
- Section VI--factors that should be considered in developing curricular and teacher-training

programs which can be implemented by other school districts; and

- Section VII--conclusions concerning the steps that can be taken to increase educational opportunities for highly able, economically disadvantaged students in mathematics and science.

II. IDENTIFYING AND SELECTING DISADVANTAGED STUDENTS

Overview of Findings

A primary objective of the programs examined in the study is to provide disadvantaged students with opportunities to develop their skills and abilities, particularly in mathematics and science. To achieve this objective, districts and schools have implemented strategies for identifying and selecting disadvantaged students who often are underrepresented in programs for the highly able. These strategies are:

- A pre-selection process, such as activity-based assessment, to identify potentially gifted students. In this process, students are given opportunities to develop and display their skills and abilities over an extended period of time, in order to increase their potential for admission into a gifted and talented program; and

- The use of multiple criteria for selecting students for admission into a gifted and talented program, rather than a single measure such as a standardized test. Criteria include achievement and aptitude test results, teacher recommendations, and students' classroom performance.

Student Identification Strategies

Economically disadvantaged students, particularly minority students, traditionally have been underrepresented in gifted and talented programs (Baldwin, 1985; U.S. Department of Education, 1986). Although minorities make up 30 percent of public school enrollment, they represent less than 20 percent of the students selected for gifted and talented programs. One factor that has accounted for this trend is minority students' performance on the standardized tests used to select gifted program participants. Researchers have found that children identified as gifted based on these tests have learning styles in which they process information analytically, and tend to perceive themselves

as being in control of their environment--i.e., they have a strong internal locus of control. In contrast, studies of minority students from inner city environments indicate that these students are more likely to process information in a global fashion, rather than analytically, and often consider themselves to be at the mercy of external forces--rather than in control of their own lives. These latter traits are those usually not found in students selected for gifted programs (Boothy and Lacoste, 1977).

Another factor that has affected the placement of minority students in gifted programs is their fluency in English. Students who have not mastered the English language--many of whom are found in our inner city schools--are less likely to be selected for enrichment and acceleration programs because most programs require that students have a strong command of the English language.

In order to increase the number of minority and other underrepresented students who are admitted into gifted programs, the following strategy has been developed to prepare elementary-level, minority students to compete in the gifted program selection process.

Pre-Selection Enrichment Program. One approach used to identify talented disadvantaged students is the implementation of a pre-selection enrichment program. In this type of program, students thought to have potential are identified a year prior to the beginning of a gifted program based on teacher recommendations and/or standardized test results. The students then participate in a full- or partial-day program, which is designed to develop their skills and abilities for mastering gifted classes and to prepare them to compete successfully for admission into a gifted program.

Activity-Based Assessment Component

During the pre-selection enrichment program, students are given opportunities to demonstrate the skills that they are learning through an activity-based assessment process, in which information about students' talents is collected through multiple measures administered over a period of time, rather than through a standardized test given in one

sitting. The activity-based assessment process provides teachers with an opportunity to analyze students' strengths and weaknesses systematically, and to tailor instruction to enhance their skills and address any deficits. This process has been found to be effective for identifying students whose gifts and talents often are not revealed through their performance on standardized tests (e.g., Cox et al., 1985).

Three of the four elementary-level efforts examined in our study have a pre-selection enrichment program. They are:

- Training of Elementary School Teachers in Mathematical Thinking Program, which prepares elementary teachers to use an activity-based assessment process to identify students' talents and to place them in programs best suited to develop these talents. In this program, teachers are trained to use materials, such as manipulatives, both to teach and assess students. Teachers who have implemented the techniques taught in this inservice program have found that students who typically test poorly on computational and verbal skills perform well with manipulatives. An example of the activities undertaken in this program is described in Vignette No. 1;

- Potentially Gifted Minority Student Project, which is a special full-year program that provides fourth grade students with enrichment activities so that they can develop their abilities to compete in the district's gifted program. Students' skills initially are assessed through the administration of a number of instruments, including the Structure of Intellect Learning Abilities test (SCI-LA). The results of these tests are used to structure a course of study for students that emphasizes the development of critical thinking skills. During the year's program, students are given opportunities to demonstrate the skills they learn through standardized tests as well as through interviews with teachers; and

- Encendiendo Una Llama, which is a bilingual program designed to prepare elementary students for admission into the district's monolingual gifted and talented program. Based

Vignette No. 1

IDENTIFYING STUDENTS THROUGH ACTIVITY-BASED ASSESSMENT
Training of Elementary School Teachers in Mathematical Thinking
Fort Worth, Texas

To illustrate place value, the teacher tosses die on an overhead across a lit screen displaying three columns--hundreds, tens, and ones. At their desks, 27 third grade students have the same chart with colored cubes and rods, which they place in the various columns to track the numbers that appear on the die. When ten ones or red cubes appear in the ones's column, students exchange the cubes for a blue rod. After a series of six throws of the die, the teacher asks, "What number do your cubes and rods show on the chart?" A wave of hands suddenly appears.

Later, in the back of the room on the floor, students play a similar game in groups of three. While two students roll a die and mark the place value chart with cubes and rods, another student arranges ten numbers from smallest to largest. When all three students have completed their work, they switch assignments.

Through an inservice training program affiliated with the district's Pyramid Project, this third grade teacher has developed lessons like the place value exercise as part of the process of learning to use manipulatives in mathematics instruction. The teacher also has acquired new skills in observation, and is using these skills to identify highly able students based upon their approach to learning activities.

In schools like this--where many of the students come from non-English speaking backgrounds--activity-based assessment is a valuable tool for identifying highly able students who often, for reasons of language and culture, do not score well on standardized achievement tests and thus are not selected to participate in the gifted and talented program.

> on Renzulli's (1977) "Revolving Door" concept, the program provides for a large pool of students to be selected for organized enrichment services that are carried out in a partial--day, resource room component. In the resource room, bilingual students engage in activities to develop their language and critical thinking skills, while teachers document their progress over the course of the school year. As illustrated in Vignette No. 2, students have opportunities to learn using computers while they enhance their language skills. Based upon their performance in the resource room and their achievement on standardized tests, students are eligible to participate in the middle school gifted program.

In these efforts, the operation of a pre-selection program with an activity-based assessment component provides students with opportunities to develop and demonstrate their potential for a gifted program. As a result of the use of this strategy, a wider range of students are being admitted into gifted programs than has been the case when students are selected based solely on their performance on a standardized test.

In the fourth elementary program examined in the study, the Chicago Public Schools' Gifted and Talented Program, multiple measures are used to choose students for the gifted program. However, students do not participate in an activity-based assessment process, and students are selected based on their performance on tests administered during a testing period, rather than over the course of a school year.

Selection of Students

Each of the nine programs chosen as case study sites uses multiple criteria in selecting its participants. The use of more than one data source is advantageous because of the difficulties in measuring the various facets of giftedness, and the likelihood that latent talents can be tapped with different assessment techniques (Hagen, 1980; Cox et al., 1985; and Passow, 1986). This process is particularly important in the identification of disadvantaged, highly able students, who may

Vignette No. 2

LEARNING WITH COMPUTERS
Encendiendo Una Llama
Hartford, Connecticut

The Swedish flag displays a yellow cross on a field of light blue--a fact that most likely would be of little significance to students in one of Hartford's inner city elementary schools. However, to highly able students in the city's bilingual Encendiendo Una Llama program, the Swedish flag is, for the moment, a matter of great importance.

Working in teams, a group of fifth graders attempt to reproduce the Swedish flag using computer graphics. The teacher graphs an X and Y axis on the black board; the students then attempt to plot on graph paper the coordinates they will use to program the computer where to put the colors.

In traditional fashion, it's a competition between the boys and the girls; the boys are the first to "draw" their Swedish flag. However, the boys' flag is the size of a postage stamp and the yellow cross appears on another part of the screen. It's back to the drawing board for the boys! The girls' first attempt fills the screen with a field of blue, highlighted by a small yellow blob in one corner. It's back to the drawing board for the girls!

According to the teachers, the students eventually realize that although the computer is the "fun part," they must spend most of their time calculating the proper coordinates on paper if they are to be successful. While the Llama program utilizes diverse instructional strategies, the teachers think the computer is an effective teaching tool. Since many of the Llama students still are learning to express themselves in English, they can use the computer to demonstrate their full range of skills, unhampered by language barriers. Furthermore, the teacher wants these students to see that the world of computers is open to all and that they can aspire to careers in technology--even computer graphics.

have skills and talents that are not measured adequately by the items included on standardized achievement tests.

The criteria or types of information considered by the case study sites in the selection of students, which are displayed in Table 3, include: standardized achievement and aptitude tests; a student's grade point average; student products, such as essays or artwork; teachers' recommendations, based on students' performance in class; parents' or students' self nominations; and a student's attendance rate.

While each of the case study sites assesses prospective participants' skills and talents through the collection of achievement test data, the relative importance of this type of information varies among sites. For example, the Detroit Area Pre-College Engineering Program (DAPCEP) relies more heavily on students' grade point average and teachers' recommendations than on achievement test results. In contrast, Baltimore Polytechnic Institute--using the Baltimore Public Schools' selection process--admits students based on their standardized test results and attendance rate. Richmond Community High School's selection process is the most comprehensive of the programs we studied. Three categories of student behavior are assessed: 1) students' performance on aptitude and achievement tests, 2) extent of students' creative abilities, and 3) students' demonstration of leadership, motivation, and adaptability, as judged by teachers' recommendations.

By employing selection techniques in which various aspects of a student's gifts and talents are considered, districts and schools have succeeded in drawing disadvantaged and minority students into their programs for the highly able. In the two districts we studied that utilize a traditional selection process based on students' standardized test performance--Baltimore and Chicago--the application of a quota system, developed as part of the districts' desegregation efforts, ensures the participation of minority students in the districts' accelerated programs.

Table 3

DATA SOURCES USED IN IDENTIFICATION
AND SELECTION OF STUDENTS

Site	Achievement/ Aptitude Test	Grade Point Average	Student Presentation or Written Evidence	Teacher Recommendation	Parent/ Student Nomination	Attendance Rate
Baltimore Polytechnic Institute	X	X				X
Challenge '85	X			X		
Gifted & Talented Program James A. Garfield High School	X			X		
Richmond Community High School	X		X	X		
Detroit Area Pre-College Engineering Program	X*	X		X	X	
Gifted & Talented Program Chicago Public Schools	X	X		X		
Encendiendo Una Llama	X		X	X		
Potentially Gifted Minority Student Project	X			X		

 of achievement test varies by program site

III. CURRICULUM AND INSTRUCTION

Overview of Findings

The nine sites selected for indepth study provide instruction to highly able, disadvantaged students through a variety of accelerated courses and enrichment activities. These instructional activities are aimed at improving disadvantaged students' performance in mathematics and science, as well as encouraging their participation in advanced courses in these fields. Specific strategies that are undertaken to accomplish these objectives are:

- The offering of accelerated classes and specialized programs, in which subjects are taught at a faster pace and in greater depth than regular classes;

- The use of hands-on learning techniques that stress the applications of science and mathematics through science fairs, projects, and independent research;

- The provision of enrichment activities, such as field trips, special projects, and mentorships, which give students opportunities to expand their knowledge in science and mathematics;

- The extension of time students spend learning, through enhancement activities such as after-school, weekend, and summer classes; and

- The provision of opportunities for independent study, in which students engage in research projects and develop their investigative skills.

The strategies used to accelerate and enrich disadvantaged students' educational experiences, displayed in Table 4, are discussed in this section.

Table 4

TYPES OF INSTRUCTIONAL ACTIVITIES PROVIDED TO STUDENTS

Site	Accelerated Curriculum	Enrichment Activities	Independent Study
Baltimore Polytechnic Institute	Structured math/science/engineering curriculum for grades 9-12; AP exams given upon request	Speakers, contests	Senior practicum in science or engineering
Challenge '85	Accelerated curriculum in math, science, and computer science for grade 11; grade 12 students can enroll in local universities and community colleges	Field trips	
Gifted & Talented Program, James A. Garfield High School	Accelerated curriculum in mathematics and science for grades 11 and 12; AP classes in math and science for grades 11 and 12; honors classes for grades 10-12	Summer and Saturday classes for math students	
Richmond Community High School	Accelerated curriculum in math, science, English, history, and foreign language for grades 9-12; grade 12 students can enroll in local universities and community colleges	Field trips; contests; mentorships; Adopt-A-school	Junior/senior independent study project
Detroit Area Pre-College Engineering Program	Pre-engineering accelerated curriculum for grades 9-12	Summer and Saturday classes; field trips	Science fair project

Table 4, (Continued)

Site	Accelerated Curriculum	Enrichment Activities	Independent Study
Gifted & Talented Program, Chicago Public Schools	Accelerated curriculum in all content areas at regional centers for grades K-6 and at academic centers for grades 7-12; honors and AP classes for grades 7-12; students in grades 7-12 can enroll in local universities	Museum program; Saturday classes	
Encendiendo Una Llama	Accelerated curriculum provided for grades 1-6 in resource rooms	Field trips	Independent projects
Potentially Gifted Minority Student Project	Accelerated curriculum for grade 4	Field trips; Thinking skills program	

Accelerated Curricula and Specialized Programs

The need to foster the achievement of disadvantaged students in mathematics and science, particularly minority students, is well substantiated. The results of tests administered in these subjects indicate that minority students are outperformed consistently by white students. The 1986 NAEP mathematics results show that at grade 3, for knowledge and skills as well as higher-level applications, white and Asian-American students performed significantly better than Hispanic students, who tended to perform better than black students. At grades 7 and 11, the significant advantage in overall performance shown by Asian-American students prevailed across the five content areas measured by the test--knowledge, skills, higher-level applications, measurement, geometry, and algebra (Dossey et al., 1988).

The trend in science is similar. Although black and Hispanic students made gains from 1982-1986, their performance gap relative to white students is still serious. Minority students at ages 13 and 17 appear to perform, on average, at least four years behind their majority counterparts. In 1986, black and Hispanic 13 year-old students showed average science proficiency below that of white 9 year-old students, and the average performance of black and Hispanic 17 year-old students was at or below that of white 13 year-old students (Innis and Jenkins, 1988).

The NAEP results over the past decade have prompted actions to address the academic needs of minority and disadvantaged students, who typically have not performed as well as their white counterparts on national tests. In an effort to reverse these trends, districts and schools have implemented programs designed to improve students' achievement in these subjects, to increase the amount of mathematics and science instruction given to students, and to foster students' positive attitudes about these subjects.

The eight classroom-based programs examined in our study have used a variety of methods to provide accelerated instruction to students, ranging from specialized or alternative chools to concurrent enroll-

ment in colleges and universities. The strategies vary by grade level of students and program structure.

Specialized High Schools. At the high school level, one option is to institute a specialized high school where students of high ability are grouped together in a separate facility to receive accelerated instruction in different content areas. Three programs in our study exemplify this model--Baltimore Polytechnic Institute (Poly), Richmond Community High School, and Challenge '85. Poly students study mathematics, science, and engineering in great depth and breadth. In this school, a strong emphasis is placed on learning the applications of mathematics and science through laboratory classes--as illustrated in Vignette No. 3. At Richmond Community High School, disadvantaged students participate in an accelerated program that is designed to enhance their academic performance in all subject areas. Challenge '85 students received specialized instruction in science and mathematics in a separate half-day program that is designed to offer students courses that are not available in their home schools.

Enrollment in Colleges and Universities. High school students also have opportunities to enroll in institutions of higher education to receive college credit for classes they complete satisfactorily. Challenge '85, DAPCEP, and the Chicago Public Schools provide students with this option, which enables them to participate in advanced courses--such as engineering--that usually are not offered at a regular high school.

Honors and Advanced Placement Classes. These two forms of accelerated instruction continue to be options for secondary students. While the subjects offered and the amount of preparation formally sponsored varies among schools, the challenge to perform well on the Advanced Placement examinations is a strong source of motivation for many highly able, disadvantaged students.

Hands-On Learning Techniques

In addition to specific programs, the way in which instruction is offered to students is specialized. Across all grade levels, attempts

Vignette No. 3

ACCELERATED MATHEMATICS AND SCIENCE
Baltimore Polytechnic Institute
Baltimore, Maryland

Wearing goggles and gloves, one Baltimore Polytechnic Institute student in Baltimore, Maryland works on the drill press to prepare wooden materials for the construction of a miniature balloon frame house. Nearby, another Poly student lays out sheet metal work using a straight edge, awl, and dividers. In this class, students will cut and form the metal according to the house blueprints--thereby applying the rigorous mathematics and science training they have received at school to the field of architecture.

In another class, a student cuts out a pattern for the split anvil on the bandsaw. Simultaneously, the Hot Metals instructor prepares a mould for casting the anvil. By observing the demonstration and then imitating the teacher, students learn copes, drags, riddling, and gates. A variety of equipment is available to students here--from milling machines to wood lathes.

Both of these laboratory experiences are required components of the engineering and science classes that Poly students take in the 12th grade. For Poly's 1,600 secondary school students, the curriculum is demanding yet worthwhile. Students soon realize that the highly technical education they receive at Poly will adequately prepare them for the engineering and science professions, or their associated technical fields.

Do Poly's 500 female students object to the grit and grime of these laboratory classes? "Why, no," explain the students. "It just gives us another chance to demonstrate our inherent superiority over the boys."

are made to apply the concepts of mathematics and science to the real world. To accomplish this, instructors relate experiences from students' daily lives to mathematical concepts--as illustrated in Vignette No. 4. Students also are given opportunities to explore the applications of mathematics and science through laboratory exercises. Each of these strategies is intended to increase students' interest in and understanding of the subject matter.

Enrichment Activities

Enrichment generally is viewed as the conduct of activities or the study of disciplines usually not found in elementary or secondary programs. In our study, enrichment activities are used to enhance students' academic skills--particularly in mathematics and science--and to expose students to cultural and community experiences that they may not have had because of their economic disadvantagement.

In the elementary-level efforts we examined, enrichment activities are an integral part of a program's identification process. The following programs illustrate this strategy:

- Encendiendo Una Llama, where students participate in enrichment activities in a partial-day, resource room program designed to build their higher order thinking and research skills. Working in small groups, Llama students carry out projects aimed at developing their abilities to solve problems cooperatively;

- The Potentially Gifted Minority Student Project, in which fourth grade students spend a year engaged in enrichment activities in critical thinking so that they can be prepared to gain admission into the district's gifted and talented program; and

- The Training of Elementary School Teachers in Mathematical Thinking Program, in which teachers are trained to create an enhanced learning environment in the regular classroom by using problem-solving techniques and manipulatives to teach mathematics.

Vignette No. 4

REAL-WORLD APPLICATIONS IN MATHEMATICS
James A. Garfield High School's Gifted & Talented Program
Los Angeles, California

As eleventh grade students enter the lecture hall at James A. Garfield High School in Los Angeles, sounds of Beethoven's "Ninth Symphony" fill the room. The students quickly take their seats and open their textbooks to Chapter 10. A short, middle-aged man enters the classroom and talks to a few of the students. After the music stops, the teacher asks, "Are you ready? Are you ready to discuss limits today?" The class sheepishly responds, "Yes." "What? I can't hear you," the teacher says. "Are you ready or not?" "Ready," the class shouts back.

Moments later, the teacher pulls a "toy" from his cabinet--a baseball and mitt appear. He slaps the baseball into the mitt and says to the class, "You know, the way the pitcher throws the ball determines the path the ball will take--am I right?" "Yes," the class responds. "What could this be?" the teacher asks as he simulates a pitcher's actions. "A curve ball," one student remarks. "A fast ball," cries out another. "You know," says the teacher, "the trajectory of the ball is what is called f of x."

Seconds later, on the blackboard, the teacher is busy explaining the concept of limits. After several practice exercises together, the students work individually on homework problems due the next day. The teacher circulates to answer any questions students might have. Finally, with ten minutes remaining in the class period, the teacher distributes a quiz with a picture of the school's mascot in the corner. The class completes the quiz and returns it to the teacher as the bell sounds. Chatter and laughter fill the room. The students have just spent 50 exciting minutes with Jaime Escalante, learning some very difficult mathematics at James A. Garfield High School.

In each of these practices, efforts are being made to strengthen and build students' critical thinking and problem-solving skills--a process that is considered crucial to the development of highly able students (e.g., Murnane and Raizen, 1988).

At the middle and secondary school levels, enrichment activities often are carried out with community or university support. In DAPCEP and at Garfield High School, students participate in weekend courses conducted at local universities to improve their skills in mathematics and science. Both programs emphasize the practical applications of mathematics and science. DAPCEP students learn about the various fields of engineering and how the high school subjects they are studying relate to the tasks engineers and scientists perform.

Programs at all levels offer students opportunities to learn about their communities and their institutions. For example, the Chicago Public Schools' Gifted and Talented Program has a comprehensive off-campus program of enrichment activities that involves museums, the Shedd Aquarium, the Lincoln Park Zoo, and the Chicago Academy of Science--as described in Vignette No. 5.

Extension of Time

A common characteristic of all of the enrichment activities is that they extend the time that students spend learning. Through after-school, Saturday, and summer programs, students receive intensive instruction in a variety of subjects. In some instances, such as Garfield's calculus classes, participation is mandatory and is considered critical to a student's success on the Advanced Placement examination. Other activities, such as field trips, are voluntary and are intended to broaden students' cultural and social awareness. The importance of increasing the time students spend learning mathematics and science is another aspect of the development of highly able students (Malcom, 1976 and 1984; the National Science Foundation, 1983).

Vignette No. 5

ENRICHMENT THROUGH EXPLORATION
Chicago Public Schools Museum Program
Chicago, Illinois

A young man, equipped with a mask, snorkel, fins, and oxygen tanks, dives into a large glass pool filled with fish and vegetation. As he proceeds to feed the various aquatic creatures, he describes what life is like in this underwater environment. Students, with their brothers and sisters, point to the oversized turtles swimming at the bottom of the pool. Awe-struck parents stand and observe the show. The Aquatic Science Program--one of 12 museum programs offered by the Chicago Public Schools Gifted and Talented Program--is sponsoring an open house for students and their families at the Shedd Aquarium. After a brief diving demonstration, students receive awards for completing the program, while a teacher describes their accomplishments.

At the Lincoln Park Zoo several miles away, a zookeeper lifts a chimpanzee from her cage and holds her before a group of 20 juniors and seniors. The zookeeper explains various facets of animal behavior, and responds to questions from the students. Before this presentation, the students learn about primates through a question and answer session in the zoo auditorium. The one-year Zoology Program also requires that students design an exhibit area for a zoo animal and justify their design before the class.

Nine eighth grade students enrolled in the Ecology Program study rain forests at the Chicago Academy of Sciences. Their teacher distributes a sheet, listing various forms of wildlife that are exhibited throughout the museum. Through a scavenger hunt, students identify the designated plants and animals from lifelike displays on the second floor. In groups of two and three, students help each other find the missing items.

At all three institutions--the Shedd Aquarium, Lincoln Park Zoo, and the Chicago Academy of Science--students engage in hands-on work. Learning is both a joy and a challenge, conclude Chicago's museum programs' participants.

Independent Study

Another strategy used to enhance students' achievement is the conduct of independent study projects, in which students are given opportunities to engage in independent research to develop their investigative skills. By undertaking original research projects, students learn to apply the scientific method to a topic of their interest. They also develop their skills at identifying problems and at applying methods for solving these problems.

Three of the programs in our study use this instructional strategy. Both Baltimore Polytechnic Institute and Richmond Community High School require that students undertake an independent research project during their junior or senior year. DAPCEP middle school students participate in the city's science fair, which enables students to develop the problem-solving and critical thinking skills necessary for succeeding in advanced courses.

IV. SUPPORT STRUCTURES

Overview of Findings

The district and school staff interviewed in our study utilized diverse techniques to inspire economically disadvantaged students to strive to reach their full potential. An element that is critical to these students' success is the social-emotional support provided by counselors and faculty. Strategies that were found to be effective in stimulating and nurturing students are:

- Setting of external goals that students can work toward, such as achieving on an Advanced Placement examination or winning an award at a science fair;
- Provision of professional role models, so that students can learn about different occupations and the requirements needed to enter these occupations;
- Provision of emotional support to students through teachers' and counselors' active involvement in students' lives; and
- Encouragement of parent participation in students' academic development and in supporting their emotional growth.

The major findings from our study regarding approaches for motivating and supporting students are discussed in this section.

Setting External Goals

An important factor in disadvantaged students' academic success is their attitude and motivation toward learning. Students who are able to develop and sustain a motivation to succeed academically, in spite of the environmental factors that may block their success, are more likely to achieve their goals. Many of the intervention programs that have been designed for disadvantaged students have emphasized the need

for reinforcement and motivation activities to encourage students' academic development.

Each of the nine programs examined in our study employs strategies to motivate students to pursue academic activities. One frequently-used strategy is the setting of an external, tangible goal that students can work toward achieving. In attempting to motivate students, faculty and administrators have found it effective to encourage students to compete in activities for which there is an award that is recognized beyond the immediate school environment. The types of incentives that are used to motivate students are described below.

Achievement on Advanced Placement Tests. At Garfield High School in Los Angeles, the Advanced Placement program in calculus is one mechanism that has been used to inspire students to achieve beyond their expectations. While the Los Angeles Unified School District has encouraged high schools to organize Advanced Placement programs to stimulate students' interest in academics, Garfield has taken a unique approach to the program. While AP classes usually are restricted to high achieving students, at Garfield all students are encouraged to meet the challenge of AP calculus. Participating in AP calculus means attending classes not only during the regular school day, but also on Wednesday evenings, Saturdays, and during the summer. One incentive given to students to encourage them to study during the summer is the availability of stipends, which are awarded by a local foundation. Jaime Escalante's constant encouragement of students, which is reinforced by Garfield's national success on the calculus AP exam, has provided students with a strong motivation to make the extra effort to learn calculus and compete on the exam.

Participation in Science Fair. At the Detroit Pre-College Engineering Program, all middle school students must participate in the yearly science fair. The preparation of a science fair project is a major component of DAPCEP's middle school science curriculum, and provides students with an opportunity to compete not only with other students in the Detroit Public Schools, but also with students from suburban school districts. The science fair process teaches students

how to conduct independent research and encourages family involvement, since students work on projects at home over the course of a semester and are responsible for transporting their projects to Detroit's Cobo Hall for display. Presented in Vignette No. 6 are DAPCEP students' experiences with the science fair.

Early Enrollment in Higher Education. Another type of external goal students can work to achieve is early enrollment in an institution of higher education. Both Challenge '85 in Oklahoma and Chicago Public Schools' academic centers provide twelfth grade students with opportunities to enroll in college-level courses at nearby universities and to obtain college credit for successful completion of these courses. As parts of accelerated curriculum programs, these opportunities motivate students to pursue postsecondary education.

Application for College Scholarships. In addition to early enrollment, a number of the secondary level programs examined in our study have established procedures to assist students in applying for college scholarships. At Baltimore Polytechnic Institute, prominent engineering schools and the U.S. Naval Academy recruit students on a yearly basis. Many of Poly's alumni are graduates of science and engineering programs, and their continuing involvement with Poly has generated opportunities for students.

Some high schools train their counselors and faculty to work with students throughout their senior year to prepare college application materials and to preview prospective schools. This process is particularly helpful for economically disadvantaged students, whose parents may not have the experience or resources to aid students in preparing a competitive college application.

Providing Role Models

Economically disadvantaged students, particularly minority students, often have not had opportunities to interact with professionals such as scientists and engineers. This lack of exposure often results in students' reluctance to pursue careers in the sciences, either because they lack information about job requirements, or they perceive

Vignette No. 6

SETTING GOALS: "YELLOW RIBBON'S NOT BAD"
Detroit Area Pre-College Engineering Program
Detroit, Michigan

Their pride of accomplishment is so great that some students take the ribbons off their projects and wear them on their shirts as badges of honor. These highly able middle school students, participating in the DAPCEP program in the Detroit Public Schools, have completed independent research projects and entered them in the metropolitan Detroit Science Fair.

In the science projects, students learn research skills by performing experiments and recording their results. One student studied the effects of acid ran on the growth of seeds, another investigated which metals are the best conductors of heat.

In addition to teaching critical research skills, the projects encourage family involvement in fostering students' independent learning. Frequently, their experiments occur at home and students must monitor results during out-of-class time. In addition, each student is responsible for completing an application to the science fair. Some have learned--to their dismay--that if you don't complete a form correctly or submit it on time, you will not be able to enter the fair.

DAPCEP provides folding screens for the science fair projects, so that students may display their projects with as much detail, creativity, or ornamentation as they desire. For DAPCEP students, the reward from the years's hard work comes from being able to show their project at Detroit's Cobo Hall, and from being recognized by both peers and the judges.

This year--for the first time--a DAPCEP student won the grand prize blue ribbon. Several DAPCEP participants brought back second place red ribbons. Every student who submits a project in the fair receives a yellow ribbon; but nonetheless, all students view their participation as a notable honor. A principal explains why the yellow ribbon is important. "It says I completed something I could take pride in as my own creation. I took it out into the world and the world recognized its importance too. Hey, a yellow ribbon's not bad."

that such careers are beyond their reach (e.g., Malcom, 1976; Marrett, 1982; Ascher, 1985; Clevell, 1987). An approach used by many of the programs in our study is to provide students with experiences in which they can meet professionals and learn about the jobs they perform and the educational requirements that are needed to obtain these jobs.

A number of the precollege engineering programs examined in our study--PRIME, FAME, and DAPCEP--have components in which students meet with scientists and engineers on a regular basis in order to learn about their work and the academic training required for science and engineering careers. DAPCEP begins the exposure process early in a student's career through its middle school science curriculum. One component of the curriculum teaches students about minority scientists through the presentation of case histories. In discussing the materials, teachers attempt both to broaden students knowledge and to encourage their formation of positive attitudes about mathematics and science.

Another approach to presenting role models is that used by schools such as Garfield and Baltimore Polytechnic Institute. Both have loyal alumni who return to the schools in the fall and during vacations to share their college experiences with students. This process is especially beneficial to Garfield's students, the majority of whom are Mexican American and are the first generation in the family to attend college.

Providing Social-Emotional Support

The programs examined in our study all attempt to address the social-emotional needs of their students. Disadvantaged students often lack the psychological support from parents and friends that is critical to their academic and social success. Because of this situation, school faculty and staff work to provide students with guidance and advice they need to maintain their motivation and to deal with academic and personal problems.

Recognizing the pressure that is felt by students participating in accelerated and enrichment courses, teachers try to provide support by

meeting with students on an informal basis or during regularly scheduled "open door" periods, as is the case at Baltimore Polytechnic Institute. Teachers at Poly have designated periods of time when they are free to meet with students to discuss academic, personal, or social issues that may be of concern to students.

Some of the programs have developed innovative ways of providing social-emotional support to students. Richmond Community High School has created a structure called the "family," in which teachers act as heads and all students belong to a "family." The families provide a milieu in which students can discuss their academic and personal problems. Vignette No. 7 portrays this family structure.

The traditional provider of social-emotional support, the school counselor, continues to be a major resource for students. However, in the majority of the schools examined in our study, the size of the counseling staff was not adequate to meet the needs of students. In response to this problem, teachers have assumed an informal counseling role and meet with students in between classes and after school. In addition, teachers often visit students' homes to consult with parents and encourage their participation in their child's educational program.

Some schools have been able to use funds provided by special programs to support additional counseling to students. An example is the Chicago Public Schools' Gifted and Talented Program, which has a psychologist and a social worker serving each of the six regional centers for gifted elementary students.

Encouraging Parent Participation

While all of the programs in our study have some form of parent involvement, the extent and type of support varies by student grade level due to the location of schools and parents' work schedules. In two of the elementary level programs, parent involvement tended to be fairly extensive. The Potentially Gifted Minority Student Project requires that parents sign a written agreement regarding their child's participation in the program, and the staff keeps parents informed about their child's progress in the program through telephone calls and

Vignette No. 7

PROVIDING SOCIAL-EMOTIONAL SUPPORT TO STUDENTS
Richmond Community High School
Richmond, Virginia

Excited and tired after a nine-day ecology field trip to the Chesapeake Bay, a fifteen-year old black girl runs up to a tall, middle-aged woman, standing by the entrance to Richmond Community High School (RCHS). "I missed you so," sighs the Community High student, as she hugs her teacher. The teacher pats the girl on her back and says, "I missed you, too, Katie."

RCHS freshmen are eager to return to civilization after their adventurous trip. Katie is especially happy to be reunited with her teacher, with whom she has formed a unique and very special relationship. Mrs. Smith is not only Katie's English teacher--she is also her "family head." At RCHS, all students belong to a "family," a "mini community" of 12-15 students from all four grade levels. Each family is lead by a teacher or "family head," who helps students to develop shared goals and values. For Katie and many of her peers who lack strong support at home, this group experience fills an important void.

Katie's "family" engages in a variety of activities designed to enhance students' emotional development. Today, the group is discussing the difficulty of balancing academic school work with extracurricular activities. Tomorrow's session will focus on the mentorship experience of a RCHS senior that has caused the student to rethink his career choice and alter his college plans.

At each family meeting, students take turns assuming responsibility for the major decisions made. Students engage in long- and short-term goal setting and planning, as well as self assessment. Above all, the family provides an opportunity for each student to develop meaningful relationships with others--to become part of a real community at RCHS.

written reports. Llama parents can participate in the district's planning and placement team process, and actively support the program by helping with field trips.

Parents of middle school students in DAPCEP often help with their child's science fair project, and more than half of the parents accompany their child to the fair.

Involvement by parents at the high school level tends to be less intensive. At Baltimore Polytechnic Institute, attempts have been made to reconstitute a parents' group that could assist with fundraising for the school. Parents of students participating in Challenge '85, a regional program that serves three school districts, find that the distance between the program and students' homes makes it difficult to organize activities. The combination of geographical distance and parents' work schedules appears to make it difficult to sustain parental involvement at the secondary level.

Generally, the extent of parent participation in students' school activities has been limited, due to the combination of parents' time and resource limitations. In light of this situation, teachers and counselors have expanded their roles by providing social-emotional support to students through formal programs as well as informally.

V. ADMINISTRATIVE AND MANAGEMENT RESOURCES

Overview of Findings

In the programs we studied, various resources are utilized in the identification and education of highly able, disadvantaged students. These resources include the organizational support provided by a school district, fiscal support for special activities and equipment, community support to expand the capacities of schools to provide services, the human support provided by staff, and the facilities and equipment needed to implement the practices. Our findings regarding districts' and schools' provision of these resources are:

- Provision of organizational support by school districts, in which district and school staff work together in managing the design and implementation of programs for highly able, disadvantaged students, including opportunities for students to continue their participation in a gifted program throughout their educational career;

- Generation of supplemental funding to support the operation of programs;

- Building of partnerships with businesses, community organizations, and universities to extend the capacity of programs to provide services;

- Provision of training opportunities for staff to upgrade their skills; and

- Existence of facilities and equipment that is marginally adequate for providing quality educational programs.

Each of these resources is described in this section.

Organizational Support

In attempting to provide specialized programs and opportunities for disadvantaged students to develop their academic potential, schools often are faced with limited organizational resources for carrying out their activities. In order to be able to serve these students, the sites we examined undertake a common approach to management--where district and school staffs work together in designing and implementing programs that are customized to meet the specific needs of the students being served. In contrast to a strategy where a district unilaterally mandates a school's activities, or where a school independently initiates and carries out programs (e.g., Cuban, 1984), the programs in our study use what can be characterized as a co-management approach (see Yin and White, 1986; Alamprese and Brigham, 1986).

In a co-management situation, district and school officials collaborate in creating and carrying out programs that are tailored to a school's situation. District officials are flexible in permitting schools to adapt a district policy to meet a school's special needs. Schools then share the programs they develop with others in the district that have similar needs.

In addition to working together, districts and schools involve community members in the operation of these specialized programs and activities. Community members often function as additional staff for carrying out enrichment programs for students.

Another form of organizational support is the effort that districts make to ensure that students have opportunities to develop their skills and talents throughout their educational careers. Each of these strategies is discussed below.

District and School Co-Management. Two forms of co-management emerged in our study, which are presented in Table 5. In the first, a district staff member identifies a need and creates a program, in concert with school staff, to meet this need. An example is the Potentially Gifted Minority Student Project, where district staff--because of their concern about minority student underrepresentation in the district's gifted program--designed an enrichment program for minority

Table 5

STRATEGIES USED IN MANAGEMENT OF PROGRAMS

Site	District Development of Program	District School Co-Management	Community Participation
Baltimore Polytechnic Institute		District allows school to use unique block scheduling to accommodate laboratory classes	Alumni and parent groups organize fund-raising activities
Challenge '85	Superintendent initiated program and secured funding from State	Three Superintendents work collaboratively to organize program; schools design student selection procedures and curriculum	
Gifted & Talented Program, James A. Garfield High School		District permits flexibility in provision of AP program	Private foundation raises money to support summer enrichment classes
Richmond Community High School	District created alternative school mechanism to meet students' special needs	School has flexibility to offer accelerated curriculum and after-school enrichment programs	Community Advisory Board oversees implementation of school policies
Detroit Area Pre-College Engineering Program		District funds program's director and district staff are represented on Board of Directors	Community Board of Directors provides management and fund-raising support
Gifted & Talented Program, Chicago Public Schools	District staff develop and manage special components, such as museum programs and fast-paced programs	Regional and Academic Centers have flexibility to design specialized curriculum and to offer enrichment activities	

Table 5, (Continued)

Site	District Development of Program	District School Co-Management	Community Participation
Encendiendo Una Llama	District staff member developed bilingual program model and obtained federal funding for demonstration project	Schools can offer pull-out program and after-school component to address students' special needs	
Potentially Gifted Minority Student Project	District staff originally developed and currently manage implementation of program	District provides program structure and schools have flexibility in designing enrichment activities offered to students	
Training of Elem. School Teachers in Mathematical Thinking		District permits participating schools and faculty to customize Pyramid Model to meet students' needs	

fourth graders to prepare them for the gifted program. In this instance, the district's staff worked with teachers and to create the curriculum and the processes for transferring it to other schools.

In Challenge '85, the idea for the program originated with a school district superintendent. He acquired the support of two superintendents from nearby districts and created a special program for highly able eleventh and twelfth graders. In this program, the superintendents and school counselors worked to develop the guidelines for selecting and maintaining students in the program.

The second form of co-management exhibited by the programs in our study is where the <u>district permits flexibility in the interpretation of policy</u>, so that a school can provide services to meet students' particular needs. One example is Baltimore Polytechnic Institute's class scheduling process. In order to provide double-period laboratory classes for science and engineering courses, Poly uses a unique block scheduling process. Unlike other schools in the district, Poly offers double period classes for a number of subjects, which allows stu ents the opportunity to learn the applications of mathematics and science.

Schools working with the Training of Elementary School Teachers in Mathematical Thinking Program have the option of reorganizing classes to serve the special needs of the highly able students identified in the program. Through this process, teachers create pull-out and in-class programs to offer enr ed and accelerated instruction to students.

The co-management model provides districts and schools with a process for working cooperatively to meet the specialized needs of disadvantaged students. With this management process, district staff have opportunities to facilitate the creation of new programs in conjunction with school staff.

An enhancement to the district-school co-management process is the <u>involvement of community members in the operation and management of a program</u>. In several of the programs we studied, community members--through their membership on a community board--are actively involved in the management of the ort. One example is the Detroit Area Pre-

College Engineering Program, which is a not-for-profit organization that operates in close conjunction with the Detroit Public Schools. DAPCEP's Board of Directors--consisting of representatives from business, the community, universities, and the school district, as well as parents--have responsibility for creating program policy and for overseeing the program's operations. The Board also has been instrumental in raising funds for program enrichment activities that are carried out with local universities. Vignette No. 8 illustrates the involvement of DAPCEP's Board.

In addition to membership on a formal board, the community--particularly students' parents and school alumni--can help to sustain a program's operations. Through their participation in school advisory committees, parents and alumni assist in fund-raising events and in providing information about opportunities for students' postsecondary education.

Opportunities for Continuous Progress. Another form of organizational support is the effort made by school districts to ensure that students have opportunities to continue their participation in a gifted program. This support is particularly critical at the elementary level, where often students participate in gifted partial-day programs up to the sixth grade, and then have no further options for special programming.

All of the elementary and middle school programs we studied provide continuous gifted programming for students at the next level. The middle school programs that follow the elementary gifted efforts include courses that emphasize the ongoing development of higher order thinking skills, such as those courses provided by the Hartford Public Schools to former Encendiendo Una Llama students.

The high school programs that serve DAPCEP and Chicago Public Schools' middle school graduates include summer and weekend enrichment courses in science and mathematics for DAPCEP students, and opportunities to attend specialized high schools in Chicago's system. In all cases, students are provided with further options to enhance their skills and abilities.

Vignette No. 8

ENCOURAGING COMMUNITY SUPPORT
Detroit Area Pre-College Engineering Program
Detroit, Michigan

Public perceptions of board meetings come from books and movies, which often portray a board as a group of "Very Important People" approving work done by others. In some organizations, the main function of a board is to provide prestigious names on the firm's stationery. This is not the case at DAPCEP--a public-private collaboration designed to provide enrichment services to highly able students in the Detroit Public Schools--where Board members are involved in every aspect of the program.

In addition to DAPCEP's Executive Director, the Board is composed of representatives from the program's sponsors, including Ford, General Motors, Chrysler Corporation, Dow Chemical, Edison Electric, and Bell Telephone. Staff from the Detroit Public Schools are board members, as are professors from the universities that offer DAPCEP's accelerated programs. There are also two parent members.

According to its president, the Board is an important component of DAPCEP. "We consider ourselves central to the administration of the program. When we want something to happen, we expect it to happen. Of course, we do everything we can to help make it happen. Any issue that is important to the functioning of DAPCEP is important to us."

Operating through subcommittees, the Board monitors DAPCEP's budget, program operations, and staff activities. For example, at one meeting the Board heard the staff's proposal for a major fund-raising campaign that would involve extensive outreach to private and public organizations. At the conclusion of the presentation, the President asked, "How can we all help?" As he spoke, every member of the board poised a pen above a pad, ready to record his/her assignment. "How can we help?" is a commonly-asked question by the DAPCEP Board.

Fiscal Support of Programs

The majority of the programs we studied operate primarily with district and state funding. Funding is an ongoing concern for each program, particularly with regard to the support of special program components. In some instances, reductions in funding have resulted in the elimination of a key component of a program.

State funds are important sources of support for the efforts we studied, and have included the states' gifted program monies, and special program funds such as Florida's Dropout Prevention monies and Oklahoma's State Grants for Academic Cooperatives.

In two instances, the U.S. Department of Education's Title II funds are being used to support teacher-training components of the programs. Other federal programs that have funded the efforts include the National Science Foundation's grant to DAPCEP for development of the middle school pre-engineering curriculum, and the U.S. Department of Education's Office of Bilingual Education and Minority Affairs' support for the development of Encendiendo Una Llama.

Private foundations, such as Sloan, have contributed to the initial development of programs. Finally, support for enrichment activities is provided by local businesses and corporations, as well as by parents and alumni. Business and corporations have contributed monies to fund field trips and summer enrichment classes. Parents and alumni have sponsored fundraising activities, such as bake sales, to generate funds for new equipment and special trips. A program's ability to provide these types of activities is particularly critical to the development of students from disadvantaged home and community environments. The sources of funding used to support our case study practices are displayed in Table 6.

Partnerships

The majority of the programs examined in our study have attempted to establish partnerships with community and business organizations and local universities to provide enrichment activities to students. In programs such as those offered by the Chicago Public Schools, the in-

Table 6

SOURCES OF FUNDING

Site	Federal: Title II	Federal: Other	Foundation	State	Local: District	Local: Private
Baltimore Polytechnic Institute					X	X
Challenge '85				X	X	
Gifted & Talented Program, James A. Garfield High School				X	X	X
Richmond Community High School					X	X
Detroit Area Pre-College Engineering Program		X	X	X	X	X
Gifted & Talented Program, Chicago Public Schools	X	X		X	X	
Encendiendo Una Llama		X			X	
Potentially Gifted Minority Student Project				X	X	
Training of Elem. School Teachers in Mathematical Thinking	X		X		X	X

volvement of museums and local universities has been essential. These institutions provide students with opportunities to engage in accelerated and enriched learning experiences that cannot be offered within a school building.

Richmond Community High School views the community as an untapped resource that can facilitate students' academic growth and socialization. Using the resources available in the community, students learn to conduct independent research projects and investigate problems related to their course work.

While the development of partnerships with community and business members is considered desirable, district and school staff recognize the effort that is needed to cultivate and maintain relationships with these individuals. Staff member support of these relationships must be delicately balanced with their responsibilities for implementing programs.

Staff Training

An important resource in the education of highly able, disadvantaged students is the staff that provide instruction to these students. One of our case study sites focuses on the upgrading of teachers' skills and classroom performance. In this program, teachers have opportunities to learn new strategies for identifying and serving highly able students through a process that requires their participation in curriculum design and evaluation.

In contrast to the efforts being provided by this program, few of the other programs we studied offer instructors opportunities for inservice training. Most instructors rely on peer assistance to upgrade their skills, or attend an occasional workshop that is sponsored by a district. While many of the teachers implementing these programs have been trained in methods for instructing highly able students, as well as in their subject areas, the replacement of these individuals poses problems for many of the schools. Of particular concern for the urban school districts is the replacement of teachers who have advanced training in science and mathematics.

Facilities and Equipment

The creation of a physical environment in which science and mathematics can be taught effectively presents a challenge to the administrators and instructors at our case study sites. Most of the districts we studied have less than optimal facilities for carrying out accelerated instruction in these subjects. The exception is Baltimore Polytechnic Institute, which has a campus equipped with laboratory and shop settings for conducting applied work in science and engineering. Even Poly's administrators work hard to maintain the quality of the laboratory facilities and to have the latest textbooks for advanced courses.

Another form of equipment that is lacking in the programs is computers. Only four of the programs--Poly, Encendiendo Una Llama, Garfield High School, and Challenge '85--utilize computers in their courses. Most programs do not have funds to purchase equipment or do not have access to shared equipment.

The provision of adequate facilities and equipment is vital to the implementation of a successful gifted program. The quality of the physical environment and the availability of up-to-date equipment continue to be issues for faculty and administrative staff.

VI. EVALUATING AND TRANSFERRING PROGRAMS

Evaluation of Program Effectiveness

A critical activity in the implementation of an educational program is the collection of data regarding its effects. All of the programs we studied had explicitly-stated goals, and all had at least one piece of evidence which indicated that they had been successful in reaching their goals. The types of goals and evidence varied by the grade level of the program. Five types of evidence were presented:

1. Successful placement of students in an elementary-level gifted program: Encendiendo Una Llama and the Potentially Gifted Minority Student Project had evidence of being successful in placing their students in gifted programs;

2. Increased student achievement: the Potentially Gifted Project, Chicago's elementary-level regional centers, and Garfield High School presented data regarding improved student achievement on standardized measures of achievement;

3. Increased enrollment in mathematics or science courses: Garfield High School students have increased the number of courses they have taken in these fields;

4. Pursuit of post-secondary education, especially in science or mathematics: Poly, Challenge '85, Richmond Community High School, and DAPCEP had evidence of their students' success in college; and

5. Improved teacher skill and attitudes: the Training of Elementary School Teachers in Mathematical Thinking Program had data regarding teachers' increased skills in elementary mathematics and improved attitudes regarding the teaching of mathematics.

While each of the programs had data, the data often were suggestive, rather than definitive, regarding a program's success.

The quality of these data illustrates the type of information that is collected by educational programs across the country. In order to encourage the efforts that are being made by districts and schools to assess program effectiveness, more incentives for data collection and qualified staff for developing evaluation designs need to be provided. While district and school staff acknowledge that the collection of data is useful, an evaluation usually is not mandated unless a program is receiving special funding. Furthermore, school staff often are not trained to conduct systematic evaluations of curricular or administrative programs. Increased efforts need to be made to facilitate the collection of meaningful data that can be used to improve program operations, and to determine the overall effects of a program's success.

Transferring Programs

An analysis of the nine programs we studied indicates that certain conditions must be present for their successful implementation in another setting. These conditions are:

- Availability of qualified staff to teach accelerated mathematics and science courses;
- Capacity to operate flexibly in a school district structure, in order to offer alternative scheduling of classes and to use multiple measures for selecting students for admission into a gifted program;
- Availability of community resources, such as corporations and museums, which can be used as sites for enrichment activities;
- Offering of advanced credit by local institutions of higher education; and
- Ability to raise monies to support enrichment activities, such as science fairs and field trips.

The extent to which these conditions are necessary varies by program, but the transfer of most of the programs we studied requires the availability of qualified staff, community resources, and funding.

VII. CONCLUSIONS AND RECOMMENDATIONS

The programs examined in this study represent a variety of elementary, middle, and high school efforts for educating highly able, disadvantaged students in mathematics and science. From our analyses of these programs, a core set of strategies and activities emerged for improving disadvantaged students' academic achievement, increasing their participation in mathematics and science courses, and enhancing their attitudes toward these subjects.

Described below are the strategies that are being used by schools and districts to address the special needs of highly able, disadvantaged students, regardless of their grade level or geographical location. These approaches can guide other schools considering such programs for their most promising students, or can be used to upgrade the education of disadvantaged students in general. Also presented below are recommendations regarding the actions that can be taken to ensure that disadvantaged students have opportunities to develop their academic gifts and talents, particularly in mathematics and science.

Improve Student Achievement

The following strategies can be utilized by schools in order to foster disadvantaged students' academic achievement:

- Extend the time students spend learning. Through a combination of accelerated classes and enrichment activities, students can spend more time learning than normally is required by school districts. Students can attend classes during the evening, on the weekend, and during the summer, so that they can strengthen existing skills and acquire advanced knowledge in mathematics and science;

- Stress the "real world" application of mathematics and science concepts. Through laboratory classes and specialized curriculum,

students can be taught the relationship between theoretical concepts in mathematics and science and their practical application. In elementary-level programs, the development of students' higher order thinking skills can be emphasized, so that they can have a base for future study in mathematics and science; and

- Develop students' investigative skills through independent research projects. Students at all grade levels can be given opportunities to learn the scientific method by carrying out independent research projects. These projects can be conducted under the guidance of classroom teachers and professional scientists, and can be part of mentorship programs and specialized curricular activities such as science fairs.

Increase Student Participation in Mathematics and Science

A variety of incentives and supports can be used to encourage students to pursue their study of mathematics and science:

- Offer career awareness activities. Through career awareness programs, students can be informed about occupations related to mathematics and science. Students can be given opportunities to visit industries that employ mathematicians and scientists, and they can participate in mentorship programs. Successful mathematics and science professionals and teachers can provide role models for minority and disadvantaged students;

- Provide specialized curricula and programs. Curricula that highlight the accomplishments of minority scientists and engineers can be used to stimulate minority students' interests in related professions. In addition, programs can be designed that provide students with opportunities to enroll in advanced mathematics and science courses at local universities and colleges; and

- Offer counseling and financial assistance. To facilitate students' participation in postsecondary education, special guidance can be provided to students regarding opportunities for financial

assistance. Special efforts can be made to obtain contributions from foundations, businesses, and industry to support students' pursuit of higher education.

Enhance Students' Attitudes Toward Mathematics and Science

A critical factor in the education of highly able, disadvantaged students is the development of students' positive attitudes toward academic achievement. The following special efforts can be made by teaching and administrative staff to provide academic, personal, and social-emotional support to students on a continuing basis:

- Provide for teacher support of students. Teachers can assist and encourage students, through meetings after school and visits to students' homes. These actions can help address the multiple needs of disadvantaged students, and can provide students with the educational and psychological support they need to succeed academically; and

- Encourage parent participation in school activities. Parents can be encourage[illegible] [illegible]o become involved in all aspects of their childrens' educational program. At the elementary level, parents can make written commitments to assist their children in their academic study. At the middle and high school levels, parents can be asked to join parent associations and to support their childrens' academic development through participation in contests and special events.

Recommendations for District [illegible]

The strategies discussed above can be implemented by school districts and schools to provide disadvantaged students with opportunities to develop their abilities and to be recognized for their accomplishments. In order to ensure that these efforts can be undertaken, school districts can provide the following supports to schools to facilitate their work with disadvantaged students in mathematics and science:

- Permit flexibility in the implementation of programs. In order to offer laboratory classes and specialized curricula in mathematics and science, schools may need flexibility in scheduling and in expending funds for materials and equipment;

- Provide staff support for the operation of special programs. The successful operation of a program may require administrative staff support from the district, in order to facilitate the participation of multiple schools in a program or to coordinate the services provided by the district to a special program;

- Recruit qualified staff for mathematics and science programs. In order to ensure that schools have staff qualified to teach advanced mathematics, science, and engineering courses, school districts may have to provide incentives for professionals from business and industry to teach, recruit new qualified teachers, and provide inservice training to upgrade the skills of existing teachers; and

- Promote partnerships with business, industry, and community organizations. In order to provide enrichment activities for disadvantaged students, school districts may have to work with local businesses and community organizations to encourage their participation in special programs and their contribution of resources for special activities.

Our analysis of the sites examined in this study has shown that while the role of the school district is important in the implementation of programs for highly able, disadvantaged students, the real success comes when schools and districts work collaboratively with the community to address these students' needs. The combined efforts of schools, districts, and the community are needed to provide disadvantaged students with the academic, personal, and social-emotional supports that are critical to their development and ultimate accomplishment.

REFERENCES

Alamprese, J., W. Erlanger, and N. Brigham. 1988. No gift wasted: Effective strategies for educating highly able, disadvantaged students in mathematics and science, volume II: Case studies. Washington: COSMOS Corporation.

______, and N. Brigham. 1986. Managing together: Handbook of district and high school practices toward excellence. Washington: COSMOS Corporation.

______. 1986. Dissemination of exemplary practices in science and mathematics education: Summary of project activities. Washington: COSMOS Corporation.

Ascher, C. 1985. Increasing science achievement in disadvantaged students. The Urban Review 17:279-284.

Baldwin, A. 1985. Programs for the gifted and talented: Issues concerning minority populations, In The gifted and talented: Developmental perspectives, ed. F. Horowitz and M. O'Brien, 223-249. Washington: American Psychological Association.

Berryman, S. 1983. Who will do science? Trends and their causes in minority and female representation among holders of advanced degrees in science and mathematics. New York: Rockefeller Foundation.

Boothy ., and R.J. Lacoste. 1977. Unmined gold: Potentially gifted children . the inner city (Report No. UDO-018171). San Antonio: University of Texas.

Boswell, S.L. 1985. The influence of sex-role stereotyp , on women's attitudes and achievement in mathematics, In Women and mathematics: Balancing the equation, ed. S. Chipman, L. Brush, and D. Wilson, 175-197. Hillsdale: Laurence Erlbaum Associates.

Carnegie Forum on Education and the Economy. 1986. A nation prepared: Teachers for the 21st century. Washington: Carnegie Forum on Education and the Economy.

Clevell, B. C. 1987. What works and why: Research and theoretical bases of intervention programs in math and science for minority and female middle school students, In Students and science learning, ed. A. Champagne and L. Hornig. Washington: American Association for the Advancement of Science.

Council of Chief State School Officers Study Commission. 1986. Education and the economy. Washington: Council of Chief State School Officers.

Cox, J., N. Daniel, and B. Boston. 1985. Educating able learners: Programs and promising practices. Austin: University of Texas Press.

Cuban, L. 1984. Transforming the frog into a prince: Effective schools research, policy and practice at the district level. Harvard Educational Review 54:129-157.

Dossey, J., I. Mullis, M. Lindquist, and D. Chambers. 1988. The mathematics report card: are we measuring up? Princeton: Educational Testing Service.

Eccles, J., T.F. Adler, R. Futterman, S.B. Goff, C.M. Kaczala, J.L. Meece, and C. Midgley. 1985. Self perceptions, task perceptions, socializing influences, and the decision to enroll in mathematics, In Women and mathematics: Balancing the equation, ed. S. Chipman, L. Brush, and D. Wilson, 95-191. Hillsdale: Laurence Erlbaum Associates.

Gallagher, J., and L. Kinney. 1974. Talent delayed-talent denied: The culturally different gifted child. Reston: The Council for Exceptional Children.

Hagan, E. 1980. Identification of the gifted. New York: Teachers College Press.

The Holmes Group, Inc. 1986. Tomorrow's teachers: A report of the Holmes Group. East Lansing: The Holmes Group.

Johnston, W., and A. Packer. 1987. Workforce 2000: Work and workers for the 21st century. Indianapolis: Hudson Institute.

Karnes, F., and E. Collins. 1981. Assessment in gifted education. Chicago: Charles C. Thomas.

Malcom, S. 1984. Equity and excellence: Compatible goals. Washington: American Association for the Advancement of Science.

______, J. Cownie, and J.W. Brown. 1976. Programs in science for minority groups, 1960-1975. Washington: American Association for the Advancement of Science.

Marrett, D.B. 1982. Minority females in high school mathematics and science. Madison: Wisconsin Center for Educational Research.

McKnight, C., E.J. Crosswhite, J.A. Dossey, E. Kifer, J.O. Swafford, K.J. Travers, and T.J. Cooney. 1987. The underachieving curriculum: assessing U.S. school mathematics from an international perspective. Champaign: Stipes Publishing Company.

Mullis, I., and L. Jenkins. 1988. The science report card: Elements of risk and recovery. Princeton: Educational Testing Service.

Murnane, R., and S. Raizen (eds.). 1988. Improving indicators of the quality of science and mathematics education in grades K-12. Washington: National Academy Press.

National Council of Teachers of Mathematics. 1987. Curriculum and evaluation standards for school mathematics, Working Draft. Reston: National Council of Teachers of Mathematics.

National Commission on Excellence in Education. 1983. A nation at risk: The imperative for educational reform. Washington: U.S. Department of Education. .

National Research Council. 1985. Mathematics, science, and technology education: A research agenda. Washington: National Academy Press.

The National Science Foundation. 1983. Educating americans for the 21st century: A plan of action for improving mathematics, science, and technology education for all American elementary and secondary students so that their achievement is the best in the world by 1995. Washington: The National Science Foundation.

Passow, H. 1986. Educational programs for minority, disadvantaged gifted students In Issues in gifted education: A collection of readings, ed. F. Kanevsky. San Diego: San Diego City Schools.

Renzulli, J. 1977. The enrichment triad model: A guide for developing defensible programs for the gifted and talented. Mansfield: Creative Learning Press.

Schorr, L. with D. Schorr. 1988. Within our reach: Breaking the cycle of disadvantage. New York: Anchor Press.

Torrance, E. P. 1977. Discovery and nurturance of giftedness in the culturally different. Reston: Council for Exceptional Children.

Twentieth Century Fund Task Force. 1983. Report of the Twentieth Century Fund task force on federal elementary and secondary education policy. New York: The Twentieth Century Fund.

U.S. Department of Education. 1988. Youth indicators 1988: Trends in the well-being of American youth. Washington: U.S. Department of Education.

_______. 1986. Elementary and secondary school civil rights survey: National and state summary of projected data. Washington: U.S. Department of Education.

Wilson, W. J. 1987. The truly disadvantaged: The inner city, the underclass, and public policy. Chicago: The University of Chicago Press.

Yin, R., D. Both, P. Batemen, S. Grinnell, and A. Scott. 1986. Validation and strategy study: Final report to the National Science Center Foundation, Inc. Washington: COSMOS Corporation.

______, and J. L. White. 1986. Managing for excellence in urban high schools: District and school roles. Washington: COSMOS Corporation.

Appendix A

STUDY APPROACH AND METHODOLOGY

STUDY APPROACH AND METHODOLOGY

The initial step in the study was to specify the questions that would guide the overall design and activities for the study. These questions were derived from the U.S. Department of Education, Office of Planning, Budget and Evaluation's statement of work for the study. Based on the questions, the study's conceptual framework was developed, which provided a logic for the identification of school district and school-level program that serve highly able, disadvantaged students. Next, criteria were determined for selecting effective programs. Nominations for sites were solicited and sites were screened to determine the extent to which they met the study's selection criteria. Finally, nine sites were chosen and case studies were conducted. This section of the report describes the study's question and framework, site selection procedures, and data collection and analysis activities.

Study Questions

The study questions, which guided the design of the conceptual framework and data collection activities, were intended to produce information about: 1) the organizational structure of school district and school-level programs that serve highly able, disadvantaged students in mathematics and science; 2) the operation of curricular practices and administrative arrangements; and 3) the effects of the school district and school-level programs on the functioning of highly able, disadvantaged students.

Eight main questions were posed in the study. These were:

Organizational Structure

- How is the school district or school-level program administered, organized, and funded?
- What district/state regulations and policies related to the education of highly able, disadvantaged students are followed by the district?

- What processes are in place at the district level that encourage the continuous progress of highly able students, and how are these students monitored?

Operations

- How does the district identify and select highly able students for its programs?
- What strategies or practices have been developed to serve these students, and how do they currently operate?
- What types of support services are provided to students and their families?
- What collaborative relationships have been formed with representatives from business, the community, and higher education to support the strategy or practice?

Outcomes

- What evidence is used to demonstrate the effectiveness of the program?

Conceptual Framework

In order to address the study's questions concerning the efforts that are being made by school districts to foster the academic development of highly able, disadvantaged students, a conceptual framework was developed. The framework specified three components: 1) the organizational factors that influence the development and operation of school district and school-level programs; 2) school district and school-based processes, which can emanate from a district, from an individual school, or from a district and school working together in a co-management relationship; and 3) student and organizational outcomes that result from the implementation of the district strategies or school practices.

In the study, organizational structure was defined as the characteristics of the administrative, fiscal, and managerial functions that are carried out by school districts and schools. For example, an administrative function is the way in which the authority for special programs is organized within a district. A fiscal function is how a school district determines the use and distribut on of discretionary monies. A managerial function is how faculty are distributed among schools.

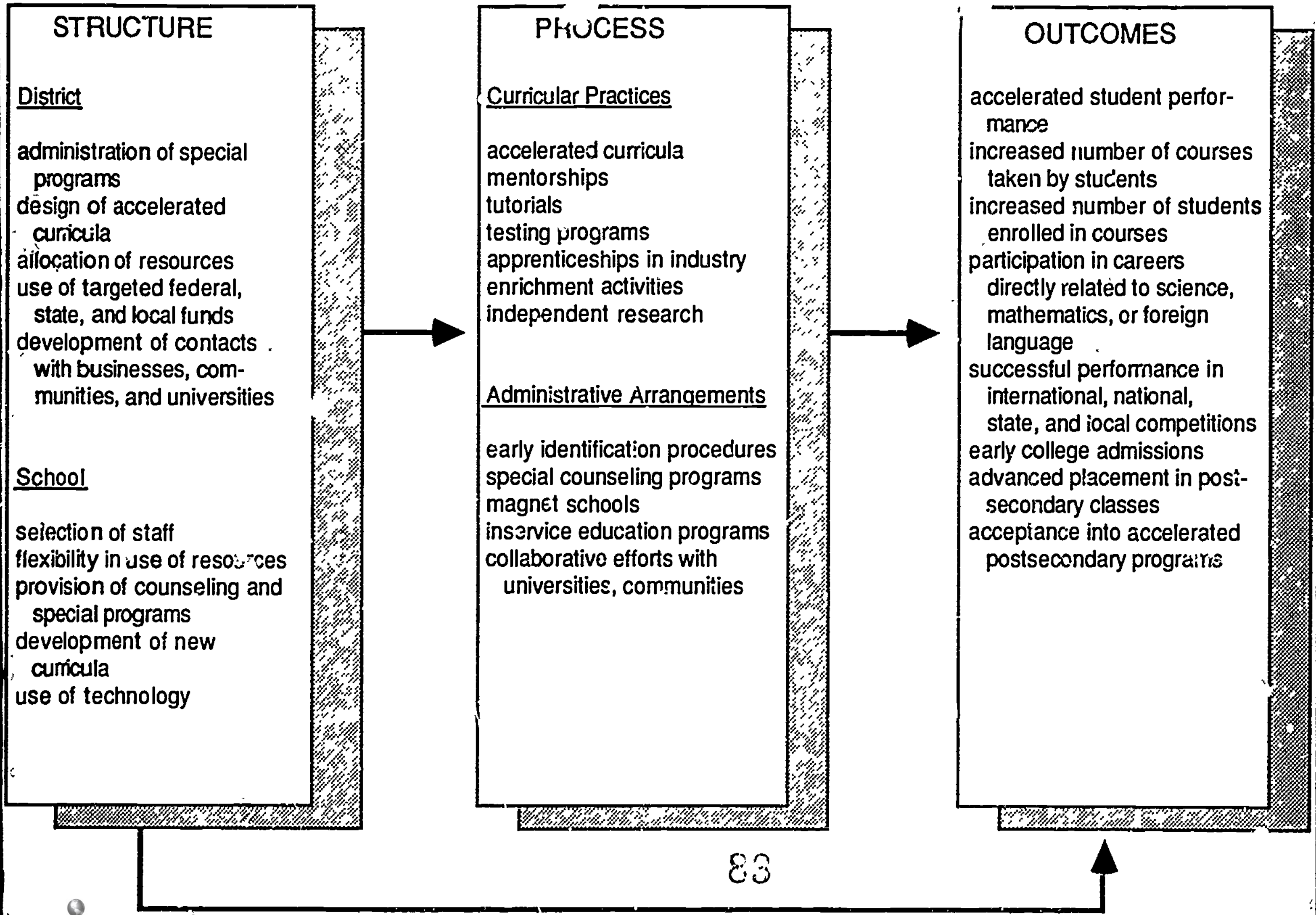
School district and school-based processes are the curricular practices and administrative arrangements that are being implemented to serve the needs of highly able, disadvantaged students. An illustrative curriculum p actice is an accelerated course in science. An example of an administrative arrangement is the procedure that a school district uses to identify and select students who can be characterized as highly able.

Student and organizational outcomes are defined in terms of student accomplishments--e.g., test performance--and organizational indicators of success--e.g., the number of students who majo in mathematics or science in college.

Figure 1 portrays this conceptual framework. At the left side of the figure is a listing of illustrative organizational functions that are carried out at the school district or school level. The ways we believed these functions would affect the practices or policies are listed in the second box in Figure 1. In the study, we expected that the practices or policies carried out by school districts and schools would result in certain types of student or school outcomes--these are listed in the third box. Also, we expected that the organizational structure of the school district and school would influence the types of student and school outcomes produced. Thus, this framework portrays the assumptions we made in the study concerning the relationships between the organization of the school district, the practices and policies that are implemented at both the school district and school levels, and the results produced by the practices.

Figure A-1

CONCEPTUAL FRAMEWORK FOR STUDY



Site Selection Procedures

In order to address the study's questions, nine effective district strategies and school practices were chosen through a multi-stage process. The selec...on of these case study sites involved three steps:

1. Criteria were specified for defining the study's major selection factors: presence of economically disadvantaged; emphasis on highly able students; a district or school-level program; and evidence of effec.iveness;

2. Nominations of sites were identified from a variety of sources; and

3. Sites were screened and nine that met the study's criteria, represented a diversity of approaches, and served a variety of student population groups, were selected for in-depth examination.

Each of these steps 's described below.

Site Selection Criteria. In order to specify the criteria for the study's key variables, the study's researchers consulted several sources of information. They conducted a literature review, met with the study's advisers, and interviewed key researchers, policymakers, and practitioners who are knowledgeable about the study's topics. Based on the information collected from these sources, criteria for selecting district and school programs were delineated.

To be a candidate for a case study site, a school district had to serve a significant proportion of economically disadvantaged students. This was defined as a district in which at least 30 percent of its students was eligible for the federal school lunch program. Within a school district, the school practice under examination had to have at least 20 percent of its students qualify for the school lunch program.

In the study, case study sites also had to serve economically disadvantaged students who were considered to be highly able. The study defined highly able in terms of the number and types of identification

measures programs used to select students. Based on the research concerning the selection of highly able students, in which the use of both quantitative and qualitative measures is advocated (e.g., Torrance, 1972; Gallagher and Kinney, 1974; Hagen, 1980; Karnes, 1981; Passow, 1986), the study specified that case study sites had to use multiple identification measures. Acceptable measures included the following: 1) performance on a standardized measure of achievement, 2) performance on an aptitude test, 3) assessment of in-classroom performance, 4) teacher recommendation, or 5) parent nomination. The multiple measures had to include at least one assessment of achievement or intelligence and one other measure.

The third criterion specified was the type of district or school program that would be appropriate for the study. It was determined that either a <u>curricular practice or administrative arrangement</u> could be considered a case study site, and should have the following characteristics: 1) serves multiple levels of talent, and 2) measures student outcomes that relate to program goals.

The final criterion used to select a case study site was its <u>evidence of effectiveness</u>. Three categories of acceptable evidence were specified in order to determine the effectiveness of district and school programs for grades K-12. These categories were: 1) student achievement, such as elementary or middle school students' annual improvement in achievement tests, or high school students' performance on Advanced Placement tests; 2) student enrollments, where students' participation in mathematics, science, or critical foreign language courses exceeds the average enrollment for the district, or where students enroll in these subjects earlier in their academic careers than their peers; and 3) student post-program participation and professional development, where students major in mathematics, science, or critical foreign languages in college, or where students' achievement in academic contests in these subject areas exceeds that of the district norm. Sites selected to be the subjects of case studies had to present at least one type of evidence of effectiveness.

In addition to meeting the study's four criteria described above, a program selected as a case study site had to have the potential for being transferred to another educational setting, or have a component that could be adopted by others. It also was intended that the sites have target student populations that range from kindergarten through twelfth grade, be located in geographically diverse areas, and represent a variety of curricular practices and administrative arrangements.

Identification of Sites. Nominations for case study sites were generated from a variety of sources. Names of candidate sites were solicited from the study's advisers and others interviewed at the beginning of the project. The authors of this report also reviewed existing databases that were thought to contain appropriate programs, such as the Department of Education's Elementary and Secondary School Recognition Program file, the Triangle Coalition database, the U.S. Department of Education's list of programs funded under Title II, and mathematics and science programs identified by COSMOS Corporation in its National Science Foundation study of exemplary practices (Alamprese, 1986). Nominations also were solicited from Chief State School Officers and Committee of Evaluation and Information Systems representatives.

Selection of Sites. A total of 79 nominations, which appeared to be strategies or practices that served economically disadvantaged, highly able students, were screened. Based on information obtained through brief telephone interviews with representatives from these sites, 29 were selected for further examination. Lengthy telephone interviews were conducted with representatives from the 29 sites to obtain detailed information about the extent to which each site met the study's criteria. An attempt was made to select nine final sites that served highly able, economically disadvantaged students across grades K-12; that represented a variety of curricular practices and administrative arrangements; and that included mathematics, science, or the critical foreign languages. The intent in choosing a diversity of sites was to determine whether there are management and support activities that are effective in serving disadvantaged students, regardless

of their grade level or geographical location. The 29 sites were reviewed, and nine were approved by the Office of Planning, Budget and Evaluation staff.

The nine final case study sites, which are presented in Table 1, Section I of this report, all met the study's criteria for serving highly able, economically disadvantaged students, represented a variety of curricular approaches and administrative arrangements, and met at least one of their goals. All nine sites have either a mathematics or a science component. While an attempt was made to select a practice that taught the critical foreign languages, the candidate sites with a foreign language component either did not meet one of the study's criteria--such as serving economically disadvantaged students--or were located in geographical areas overrepresented in the study.

The 20 sites considered in the final review but not selected for case studies are presented in Table A-1. In some instances, a site did not meet the study's criteria for economically disadvantaged, or did not have evidence of effectiveness in the areas specified in the study. In others, a program was overrepresented in a geographical area or had a weak emphasis in mathematics or science.

Data Collection and Analysis Procedures

Case Study Site Visits. In order to gather information concerning the ways in which school districts and schools are serving highly able, economically disadvantaged students, case studies of the nine sites were conducted. Using a case study protocol, which contains the study questions to be answered, the types of data to be collected, and the individuals to be interviewed, two researchers spent approximately four days at each site. While on site, the researchers interviewed school district and school personnel, students, parents, businesses, community and school members, and state education department staff; observed each of the program's operations; and reviewed available written documentation concerning the program.

Table A-1

SUMMARY OF PRACTICES NOT SELECTED AS CASE STUDY SITES

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
1. Forum to Advance Minorities in Engin. (FAME), Inc. Dover, DE	M,S Engin.	Enrich., Tutoring, Curric., Career Aware.	Students: Grades 7-12	25%/N.A.	Pre-college engin. program that offers school-year activities (clubs, test-taking skills, job readiness, tutorials) and summer enrich. programs, including residential programs at the University of Delaware.
2. Academy for Science and Technology, Wilson High School Rochester, NY	M,S, Comp. Sci., FL(Span., Ital., Fr., Ger.)	Magnet School (Curric.)	Students: Grades 9-12	70%/41%	Mathematics, science, computer science magnet school, requiring four years each of math and science and 3.5 years of computer science; curriculum features AP courses, academic competitions, independent research, and internships.
3. Manchester GATE Elementary School Fresno, CA	M,S, (Span.)	Magnet School (Curric.)	Students: Grades 2-6	20%/34%	Elementary magnet school with emphasis on science, mathematics, and computer technology. Program includes enrichment component, tutorials, mentorships, and parent involvement.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
4. PRIME, Inc. Philadelphia, PA	M	Curric., Career Aware-ness, and Motivation	Students: Grades 7-12	75%/N.A.	Pre-college engin. program that has three main emphases: 1) academics; 2) career/college preparation; and 3) motivation. Strongly supported by government agencies, businesses, private foundations, and colleges/universities.
5. Bronx High School of Science Bronx, NY	M,S, Tech., FL (Jap., Russian, Chinese)	Curric., Independ. Research, and Mentorships	Students: Grades 9-12	23%/50%	Public high school with math, science, and tech. focus. School offers mentorships, tutorials, enrichment, collaboratives, summer program, and academic competitions. Has strong ties with local museums, universities, and industry.
6. Retraining Prog. to Facilitate Sec. Ed. Certif. in Math and Science Shreveport, LA	M,S	In/Pre-Service Training	Uncert. M/S Teachers for Grades 9-12; Industrial Professionals	N.A./30%	In/pre-service training program for high school level teachers with three primary components: 1) training in the preparation and use of self-paced learning packages; 2) instruction in math and science teaching technologies; and 3) formal courses in math and science.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
7. Chinese Immersion Program West Portal Elementary School San Francisco, CA	FL (Chinese)	Curric.	Students: Grades K-3	30%/93%	Immersion program that integrates Chinese into various content areas, such as health, science, and social studies. Classes are taught 80% in Chinese and 20% in English.
8. Gifted Math Program (GMP) Buffalo, NY	M	Curric.	Students: Grades 7-12	15%/40%	University-operated program that features six-year math curric. with emphasis on abstract mathematics theory, and problem solving. GMP courses are taught at state university campus and are a full substitute for regular mathematics curricula at home schools.
9. STEP and TAG Programs Prince George's County, MD	M,S	Indentification Prog./Curric.	Students: Grades K-12	25%/21%	STEP prog. identifies disadvantaged, minority students in grades K-1 for district's gifted program; TAG provides opportunities for gifted students to develop their talents through comprehensive magnet school program.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
10. Mathematics and Science Program Kinston High School Kinston, NC	M,S	Curric.	Students: Grades 7-12	40%/50%	Prog., which serves a large minority student population, offers a variety of math/sci. courses (AP, accelerated, and advanced). Courses are supplemented by collaboratives with industry and universities.
11. University High School Newark, NJ	M,S	College-Prep. Magnet (Curric.)	Students: Grades 7-12	80%/85%	College-prep. magnet school with math/science program that offers an advanced track for gifted students. Curriculum is supplemented by collaboratives with colleges and universities for enrichment and independent research.
12. Horizon Program Seatt[illegible]blic Sch[illegible] Seat[illegible]	M,S	Curric. with Enrichment	Students: Grades 1-12	15%/29%	Enriched curric. for highly able students with an emphasis on problem solving and small group projects at the elementary level. Program is offered at all levels, with middle/high school programs featuring AP courses, and collaboration with business and industry.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
13. Magnet School Program Fort Worth Indep. School District Fort Worth, TX	M,S Related Professions (Engin., Medicine, Comp. Sci.)	Magnet Schools (Curric.)	Students: Grades 1-12	5%/60%	Wide variety of magnet schools at elementary, middle, and high school levels in math, science, and related professions. Magnet programs feature small class size, modern facilities and equipment, independent study/research, and specialized instruction.
14. Russian Program De Laney High School Timonium, MD	FL (Russian)	Curric	Students: Grades 7-12	5%/25%	Program offers five full years of Russian, of which the last two years are honors level. Prog. includes language labs, guest speakers, and academic competitions.
15. Program Quest Newton County High School Covington, GA	M,S	Curric.	Students: Grades 9-12	35%/45%	Four-year program of gifted courses in math, science, language arts, and social studies. Prog. employs enrichment triad model, which has three types of activities: 1)general exploration; 2)group training; and 3)individual/small group investigation of real-life problems.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
16. Japanese Prog. Lincoln High School Portland, OR	FL (Japan.)	Curric.	Students: Grades 9-12	5%/26%	Four-year Japanese prog. features team teaching by native speaker and Japanese instructor; year-round student exchanges in Japan; and a "sister-school" relationship with a Japanese high school.
17. Xavier Prep. School New Orleans, LA	M,S	Curric.	Students: Grades 9-12	60%/N.A.	Rigorous high school program designed to prepare minority disadvantaged students for participation in post-secondary education. Program features AP courses and concurrent enrollment at local universities for advanced students.
18. Multilingual Middle School Program San Antonio Independent School District San Antonio, TX	FL (Japan., Fr., Span., German, Latin)	Curric.	Students: Grades 6-8	12%/60%	Multilingual prog. for middle sch. students that includes instruction in both language and culture of the foreign countries studied. Enrichment is provided for highly able students in program, who can continue with language study in high school.

Table A-1, (Continued)

Practice	Substantive Focus	Practice Type	Target Population	% Eco. Disad. (Prog./Dist.)	Brief Description
19. Classroom Research Project Houka, MS	M	Curric., Research	Students: Grades K-12	N.A./62%	District-wide action research program to improve critical thinking and self concept of students. Curriculum is being revised to emphasize critical thinking and problem solving.
20. Leap Program Ganado Unified School District Ganado, AZ	M	Curric.	Students: Grades K-12	N.A./70%	District-wide program in mathematics and language. Majority of students in district are Navajo Indians, and program is designed to improve their language skills so that they can pursue other academic areas. Computers are used to facilitate language and math instruction.

Data Analysis. Based on the results of the case study site visits, case studies were prepared for each of the sites visited. In addition, a cross-case analysis of the nine sites was undertaken to determine the common and unique strategies that are being used to serve disadvantaged, highly able students in mathematics and science. Where possible, information from the 20 sites that were the subject of telephone interviews was included in the analysis of the findings.